

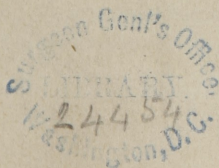
Prof. Amussat (Sept.-Aug.)

ON THE EMPLOYMENT OF

WATER IN SURGERY

BY
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OF PARIS.

TRANSLATED FROM THE FRENCH
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TO MY VENERABLE GRAND-FATHER.

TO MY FATHER,

MY BEST FRIEND AND MY PRECEPTOR.

ALSO,

TO MY UNCLES,

L. BOYER AND FILHOS.

I BEG M. M. LE VAILLANT, TROUSSEL, GAUBERT AND PORCHAT, TO RECEIVE
HERE THE EXPRESSION OF MY GRATITUDE FOR THE COUNSELS WHICH
THEY HAVE SO FREELY GIVEN ME RELATIVE TO THIS WORK.

TRANSLATOR'S PREFACE.

IN offering to the public a translation of the *Thesis* of M. Amussat, who was at the time of its composition a candidate for the Doctorate in Medicine, we believe we are performing an acceptable service. That the work contains interesting historical information, and valuable practical suggestions upon a subject of great importance, are circumstances in themselves, independant of the position of its author, which establish its claim to attention. But it is affirmed to have been written under the instruction, and to embody the experience, as far as relates to the use of Water in Surgery, of his illustrious father, and in so much it may be regarded as an original record of the views of a master.

We find also an additional reason for its publication in the exigency of the times, when empirics are every where assuming to themselves the honor of having first introduced water as a hygienic, and therapeutie agent, and are claiming the right to its exclusive use. We do not expect to arrest the streams which are daily pouring their golden tides into the pockets of these men, but simply to establish to whom the right of discovery actually belongs, and thereby, perhaps, induce some practitioners to divert and appropriate to their own use as much of this element as may subserve a useful purpose.

For the manner in which the work has been accomplished, an apology is undoubtedly due both to the public, and to the author, to whose politeness we are directly indebted for the original copy, and who, perhaps, would have hesitated to permit himself to be thus uncerimoniously introduced to his cisatlantic neighbors.

It was undertaken as a contribution to the "Buffalo Medical Journal," and has been written *currente calamo*, at intervals of leisure, and page by page as called for by the compositor, and often therefore without time for correction. We hope, however, whatever may be its faults of style, it will be found that the matter and spirit of the original has been faithfully conveyed in the translation.

FRANK H. HAMILTON.

BUFFALO, April 8, 1851.

INTRODUCTION.

In choosing as the subject of my inaugural dissertation the "use of water in Surgery," I have intended, after having made historical researches to compile most of the observations which have been published, as well as those unpublished, which pertain to the practice of my father, with the view of demonstrating the incontestible success which has attended the use of water in the treatment of surgical affections.

Next I have endeavored to determine in what surgical diseases we may, and ought to, have recourse to it.

was also my original purpose to divide my work into four distinct parts.

1. History of the employment of water in surgery.
2. General considerations and various modes of application.
3. Classes of maladies in which it ought to be applied.
4. Special observations and modes, with reference to regions.

But the multitude of facts which I found in my possession, and the space occupied in the consideration of the diseases which demanded its use, compelled me, reluctantly, to limit the plan I had laid out for myself, by considering at present but the two first, viz: the "History," with "General considerations and various modes of application."

One point of paramount importance to which myself and my father have directed especial attention, is the proper *temperature* of water. After a careful analysis of the inconveniencies which have been attributed to this agent, we have ascertained that they were due mainly to the cold. We are convinced that water at 18° to 25° centigrade (64° to 77° F.) possesses in general nearly all the advantages of cold water without any of its inconveniences. It appears to me, therefore, that the use of water at this temperature, ought to be the rule and the use of cold water the exception.

I regret that I cannot give to my subject at this moment, all the latitude which its importance demands; yet I hope to be able to demonstrate that water, skillfully applied, is a most potent topical application — that it is preferable to all others, and that we may make it the basis of a rational therapeutics in a majority of surgical affections.

However, I propose at some future time to resume this work, and to render it as complete as possible, especially in its practical portions. I will then publish the numerous cases which I cannot now make known, and I will examine with care what classes of surgical maladies can be advantageously treated by water.

HISTORY OF THE EMPLOYMENT OF WATER IN SURGERY.

CHAP. I.

I was curious to know how an agent so simple, and at the same time so powerful, as water, has been appreciated by the surgeons of antiquity, of the middle ages and of modern times. It is this, therefore, which I have undertaken to ascertain in the present historical review, and with a full understanding that I am yet far from having exhausted a subject so extensive. I think, nevertheless, that I have been able to prove that this therapeutic agent, whose value has not always been appreciated, has been gradually occupying a place of more and more importance in surgery.

Hippocrates, whose writings furnish an excellent summary of practice up to his time, has left us some precious documents upon the subject before us. In cases of ecchymosis, contusions, stretching and rupture of muscular fibres, in luxations, sprains, diastasis, fractures extending into articulations, etc., etc., he prescribes, after the application of suitable bandages, copious affusions of water.

In luxations of the astragalus, calcaneum, and in all articular lesions he recommends warm affusions.

In comminuted fractures with protruding splinters, and laceration of the integuments by the bone, he gives the following advice: "If in the summer, the compresses should be frequently moistened with wine; if in the winter, undressed sheep's wool, saturated with wine and oil, should be applied. Under the whole there should be placed a sheep's skin, to enable the liquids to drain off, and to keep the parts open to view, remembering that parts which remain a long time in the same position, become touched with excoriations difficult to cure."

We see, then, that physicians of antiquity employed, in the treatment of wounds, not only water, but also wine, oil, and decoctions of aromatic plants.

In the book of Aphorisms, we find rules on the temperature of therapeutic agents, the judiciousness of which every day's experience sanctions, and which, perhaps, have been too much neglected.

Celsus, who extolls more than any one else the use of water in internal, as well as external, affections, expresses himself thus upon the subject of the dressing of wounds: "a sponge immersed in cold water, alone answers in slight cases; but whatever may be the liquid with which it is charged, it allays pain so long as it is moist: *therefore we must not permit it to become dry.* In this way we may heal wounds without having recourse to *foreign, scarce and compound* medicaments."

Farther on we find the following passage: "if adhesion has commenced, and if there is but slight tumefaction, we must adhere to the first kind of dressing; but if inflammation is active, and there is no hope of agglutination, we ought to employ suppuratives. The use of warm water is equally necessary to resolve engorgements, to diminish hardness, and to render suppuration more active. *The warmth of the water must be such, that the hand, when plunged into the liquid, shall experience an agreeable sensation;* and it is well to continue this application until the wound appears less swollen, and has a more natural temperature."

Celsus further recommends the use of water in hemorrhages, fractures, diseases of the eye, &c.

Galen, whose writings had so much influence upon physicians and surgeons, in all the middle ages, employed water in a great number of affections. In his "Treatise on the nature and properties of simple remedies" he investigates the action of snow and of cold water upon our tissues.

In wounds he employed successively warm water, wine, vinegar, and he recommended especially affusions of warm oils for those cases in which nerves and tendons were implicated. He cites many cases of cure by this last method; and having had his own clavicle luxated upon the scapula, he treated himself in this way.

In Aetius we find for the first time the word *irrigatio*; but at paragraph 172, we read the following passage: *Irrigationibus utimur uti ob obliquam circumstantiam adhibere prohibemur*, which proves that he made little use of irrigations, and that he especially confined them to medical diseases.

Rhazes advises warm water in fractures, and cold water, or rose water cooled by ice in burns.

Avicenna reproduces in his works the great principles laid down by Hippocrates and Galen, upon the use of water and oil in the treatment of certain surgical affections.

According to M. Malgaigne, Marianus Sanctus had projected a commentary upon the entire surgical works of Avicenna. He intended to teach *a new mode of curing wounds, even those of the gravest character, by means of pure water alone, only adding thereto certain words; for all the art of medicine consists in words, herbs and stones!* "This work," continues M. Malgaigne, "has not been published; there remains nothing of it but the preceding quotation, which I have recalled for a double purpose. It enables us to see how Italian surgery had declined after Jean de Vigo, since his best pupil had come to have faith in such superstitions; and it discloses to us the true origin, in modern times, of a mode of treatment generally ascribed to Michel-Ange Blondus."

In 1542, Biondo or Blondus published a work entitled *de Partibus ictu sectis citissime sanandis et medicamento aquae myres invento*; in which he recommends water as a new and efficacious remedy in the treatment of most wounds. But we have just seen that Marianus Sanctus had preceded him in this discovery.

Ambrose Pare is the first French surgeon who uses the word *irrigation* which he defines as follows: *embrocation, according to the Greeks, or irrigation, according to the Latins, is a sprinkling, similar to rain, when from a height, we allow a decoction to fall, drop by drop, upon some part.*

Water at this epoch was especially employed by empirics, who, after the example of Marianus, Sanctus, and Blondus, only used it with the aid of sorcery and conjuring words. This induces our own great surgeon to write; "I will not omit to say that some cure wounds with pure water, after having pronounced over them certain words, and having applied linen cloths cut in the form of crosses and saturated with water, often renewed. I affirm that it is neither the words nor the crosses, but it is the water which

cleanses the wound, and by its coldness repels the inflammation and the fluxion which might attack the injured part, in consequence of the pain. This healing can be accomplished when the wound is in a fleshy part, and in a body young and of good habits, and where the wound is simple."

This passage shows that A. Pare appreciated water at its just value, and sought to disembarass its use from the superstitious practices of charlatanism.

1560. Gabriel Fallopius, imbued with the doctrines of the early physi-

cians, recommends pure water and tepid in the dressings of ulcers; but in luxations he insists that it should be mixed with oil. This distinguished surgeon closes his chapter on wounds with the following passage: *Imo ego attestor vulnera vidisse sanata ex aqua etiam non benedicta.*

1570. Philippus Palatius, whose work *de vero methodo quibus cumque vulneribus medendi, cum eo medicamento quod aqua simplici et frustulis de cannabe vel lino constat*, is very rare, (and which I have not been able to procure,) has been variously estimated by those who have read it. Percy and M. Scoutetten eulogise it; M. Malgaigne differs in opinion with the surgeons just mentioned, and gives an analysis of the mode employed by Palatius.

We extract the following passage: "Palatius," says he, "teaches to cover the wound with three *frustula*, cut into a nearly circular form, preferring well dressed male flax or hemp rather than female. I thought at first," continues M. Malgaigne, "that these must be pledgets of tow; but he speaks clearly in another place of tow, of which a separate pledget is to be made, covered with the white of an egg and applied immediately to the wound; and the *frustula* of hemp was placed over this. *The whole must be moistened night and day with simple water, at such a temperature as that its refreshing effects may be obtained without discomfort to the patient.*" This exposition is remarkable for its paucity of ideas and prolixity of phrases.

1577. In a learned discussion which took place between Dangaron, L. Joubert and Martel, the latter sustained this proposition: *gunshot wounds may be cured with simple cold water*, and with such soundness of argument that he finally convinced M. Joubert. This surgeon closes, however, by saying: "cold water possesses all the qualities requisite to accomplish a cure, and will answer the indications in every instance, provided the system be *otherwise strong, the heat vigorous and the body in good condition.*"

Martel, in his *Apologie pour les chirurgiens*, resuming the same subject, declares in his fifth paradox: "most wounds may be healed by a simple remedy, which is common water or oil."

In the explanation which he gives, he expresses himself thus: "I repeat then, that I have treated many wounds with water alone, being in the army deprived of other means, and I have seen very happy results from it..... But I think one of the principal means to expedite the cure of wounds, is to keep them very clean; now water thus cleanses and deterges. Water, by its coldness, tempers the heat of the humors, and drives them elsewhere, and serves as a repellent."

More than a century now passes without our finding any thing worthy of

note upon the use of simple water. Notwithstanding the efforts of Fallopius and of Martel, ointments, powders, plasters, miraculous waters of all kinds, are preferred to a medicinal agent which doubtless in the view of men of that age had the great fault of being too simple.

At the beginning of the 18th century, some writers endeavored again to attract attention to the use of water in surgery.

Smith, in England, in his "Treatise on the medicinal virtues of common water," devotes several pages to the treatment of contusions, ulcers, sprains, hæmorrhages and wounds, with simple water.

1713. Sancassini published at Venice a small work in which he makes mention of pure water in the treatment of wounds. In the 36th and 37th "*centuries*," he expresses himself thus:

"Pure spring water is employed by many surgeons in the treatment of even very grave wounds. There is no superstition in believing in the cures which it effects; for it prevents any thing from interfering with nature, which is the true physician, especially in wounds.

"Dogs," says he, "cure their wounds provided they can lick them. Their saliva is a balm which nothing equals; it prevents the air from harming the wounds."

And farther on, "the remedies generally recommended for wounds, are more hurtful than useful, they act as foreign substances."

In 1732, Lamorier read before the public assembly of the "Royal Society of Sciences of Montpelier," a memoir upon the use of common water for wounds; we regret that we have not been able to find this work, and that we are obliged to limit ourselves to the following extract made by Paul:

"It is surprising that common water is not more in use for wounds; perhaps the remedy is too common. The public value lightly what nature gives us in profusion; but places a high estimate upon that which is scarce, or comes from afar off, or is perchance dearly purchased, or is involved in mystery. Many also think that a remedy so simple as water can have no efficacy. To remove these prejudices Lamorier has made many experiments: among others three several experiments were made in the month of January last, upon three men, of whom one had an old ulcer upon the outer side of the ankle, of the size of the palm of the hand. The second, a soldier of the regiment of Medoc, had received a blow from a sabre upon the back of the hand, which had cut the extensor tendons of the thumb and fingers, and had separated the two bones of the metacarpus which sustained the little and ring finger. This wound was followed with fluxions and abscesses, which involved almost all of the forearm. The fever and the drying of all

his body, caused serious apprehensions that he would die. The third, another soldier of the same regiment, had received a sword cut across the forearm, which had opened the artery which lies between the bones. Much blood was effused among the muscles and extensive suppuration occurred. A copper boot was constructed, in which was placed common warm water for the purpose of immersing therein the ulcerated leg; in this bath the patient rested the limb an hour each day. A few days after the hard borders melted away, the cicatrix advanced insensibly, day by day, and he was completely cured.

“Two machines of sheet iron were also constructed, in which the two soldiers could comfortably immerse the arm from the hand to above the elbow. By bathing their wounds in water, suppuration became much more healthy; they were able to move the fingers with greater ease, the pain and the fever diminished daily; in a word, they were entirely cured.”

Thus we see to Lamorier is due the credit of having first thought of prolonged local baths in the treatment of surgical affections. This new mode, it appears also, attracted public attention, for some years later, Chirac reports that the Duke of Orleans having been severely wounded in the left hand, during the siege of Turin, he was cured by prolonged local baths in the waters of Balaruc. I might have reported this case complete and have examined what may be the influence of mineral waters also in the treatment of wounds: but such researches would have led me too far, and beyond the limits which I have traced for myself.

Gradually this method of treating wounds with prolonged baths of simple water was forgotten, and, as we shall see, more than a century afterwards, this ingenious idea was brought forward anew and extolled by a Swiss surgeon.

Water was also employed in surgery in Germany nearly at the same time that we see Lamorier advocating its use in France.

The period was moreover very favorable; the great Frederic was then astonishing Europe by his victories, and furnished to the surgeons of his army frequent occasions for the employment of a mode of treatment so efficacious and so simple. It is indeed upon battle fields, where every thing is wanting, that we are obliged to depart from ordinary rules, and give the preference to a dressing the most simple, sometimes the only possible dressing, for water can always be obtained.

Theden, a very distinguished surgeon in the armies of the king of Prussia, although very partial to his *eau d'arquebusade*, has left us the very interesting case of a subordinate officer of the regiment of Budembrok, whom

he cured of a violent inflammation of a lower limb, by enveloping it in cloths wet with cold water, and kept constantly moist.

He relates also, that having been pricked in the end of his finger by his bistoury in opening a fistulous depot in the anus, the pain, slight at first, became soon intolerable. The disease propagated itself along the forearm, attacked the elbow joint, which became very painful; the limb swelled considerably, and fever was lighted up. Finally, in a short time the progress of the malady was such that he determined to have his arm amputated. But being reminded of the good effects of cold water, he wished, before submitting to this operation, to make a trial of it: and the success was so remarkable, that, contrary to his expectation, he was promptly and completely cured.

Schmucker, Dauter, Boenerken, Ritcher and Platner, also frequently resorted to water in the treatment of surgical affections, but often combined with it saline substances.

The learned surgeons whose works have illustrated the Academy of Surgery, have contributed not a little by the reforms which they have sought to introduce into dressings, and especially in purging surgical therapeutics of the mass of balsams and salves whose value was more than problematical, to prepare the way into which others have since entered, and which tends to widen itself day by day. Although no special memoir has been devoted to the subject of the employment of water in surgery, the numerous passages which follow, quotations from the "Memoirs" and "Prize Essays of the Academy of Surgery," enable us to appreciate how the ancient edifice of Arabian polypharmacy was sapped at its foundations.

Recollin, in a work upon "the utility of injections of warm water into the womb, when portions of the afterbirth remain, after an abortion," cites three conclusive cases, and argues his title to the priority in the use of the means which he recommends; he continues in these words; "My observations do not leave a doubt — I have myself made the injections into the actual cavity of the womb. I have observed also the good effects they are capable of producing where putrefaction and suppuration are present: which is sufficiently shown by my first case. I use nothing but pure warm water, to which I shall always give the preference over decoctions or preparations of any kind, because simple water must naturally be more dissolving than what is charged with foreign particles, which give it always more consistency or viscosity. It is preferable, therefore, when it is only designed to expel purulent and fetid humors, or to dissolve blood-clots, and especially to remove by the impulsion of the fluid portions of the afterbirth retained in the womb."

The use of water in the cases cited by Recollin, has been improved upon latterly by M. Wuillamoz-Blanc.

Pibrac, in reporting a case of crushed finger, says: "My dressings were plain. The upper part was enveloped with compresses dipped in simple cold water of marshmallows. The cure has been very rapid.

"Greasy remedies relax improperly, resins and balsams united with grease, to form digestive salves, possess stimulating properties by which the fleshy parts are necessarily irritated; it is not surprising then, that the suppression of these remedies should have such favorable effects.

"I have used cold dressings, because I am persuaded that warm fomentations, by rendering the humors thin, contribute not a little to the primitive swellings which supervene to wounds."

De Lamartiniere, in a "Memoir upon the treatment of wounds from fire-arms," expresses himself thus: "In regard to topical applications, there is, in my opinion, nothing preferable, especially during the first days, to *sea water*; it resolves coagulated blood, an accident of severe contusions which sometimes ends in gangrene. This remedy so simple, and which is every where found, is a grand resource in the most extensive contusions."

Tollin reports the history of a lady, about sixty years old, who received upon her left foot, a stone which had fallen from the third story. Several toes were broken and separated from the foot.

"I proceeded," says he, "to separate the great toe entirely, I dressed the wound at first simply with coarse charpie, I then enveloped the foot and the leg with several compresses which I adjusted with a few turns of a roller. I ordered these compresses to be wet with an *emollient decoction*, and to renew the fomentations every two hours without disturbing the dressings.

"When I did open it, I found the wound in a good condition; I then dressed it with a digestive salve, and directed two poppy heads to be put into two pints of emollient decoction, with which the compresses were to be moistened every hour. . . . This treatment had all the success which I had hoped from it; the patient was completely well on the forty-eighth day."

Among the Memoirs which have been presented to the Academy of Surgery, and which have obtained prizes, we find several in which mention is made of the advantages to be derived from the use of water in surgery.

"There are," says Mannoni, "some ulcerations accompanied by severe contusions which dry up under the use of cold water; this adjuvant employed skillfully, arouses the diseased part to action, as we shall see by the following history:

"In the winter of 1746, the son of an advocate fell in descending a ladder; he lifted himself up with his face sadly bruised, having a large contusion upon his forehead, eyelids and nose, beside a long wound on the inner surface of his upper lip, but which was, in fact, not very deep. Having been called to see him, I used no other remedies *but fine sponges saturated with fresh water*. The servants were diligent in renewing the applications as well upon the bruises as upon the wound, and five days after the fall, the patient was perfectly well."

"*Water*," says Guyot, "*is the first, the most powerful and the most universal emollient; I speak of fresh water in its most simple form. . . .*"

"But that water may prove emollient, it must be neither cold, nor too warm; we know that cold water, far from relaxing the fibres, produces a constriction and considerable retraction; this is proved by the disappearance of veins, before apparent, from the surface of the body, under the influence of cold, and by the experience of many practitioners who have reduced hernia's by pouring or applying cold water or snow upon the tumors, and who have arrested considerable hemorrhages with the same remedy. . . .

"It is necessary, then, that water should have a moderate warmth, nearly the temperature of the sound body, in order to produce an emollient effect.

"Experience demonstrates its usefulness and its good effects when applied externally in the form of vapor baths, fomentations and *douche*.

"Most topical emollients derive their chief value from the water, such as fomentations and emollient cataplasms."

"Lukewarm water," according to the illustrious Louis, "is of all medicaments the most simple. Yet we derive from it benefits without number; *lukewarm water* relaxes parts which are over stretched, opens the pores; the particles of water insinuate themselves into the vessels, dilute the fluids, and increase the diameter of the small invisible vessels, they facilitate the flow of humors, and open passages to substances which need to be expelled. It is for all these reasons that Pare recommends fomentations of lukewarm water in several places, and especially in the thirtieth chapter of the fifteenth book upon "fractures."

"Common water, which contributes," says Poutier, "to the preparation of most remedies, and which supplies them with a convenient vehicle is itself, *when lukewarm, the emollient par excellence*."

"Water, as a sedative and antiphlogistic," says Mopilier the younger, "diminishes the irritation of the vessels, relaxing them by its liquidity."

Champeaux washes wounds with tepid water and with wine. Sometimes he bathes the wound every three or four hours with vegeto-mineral water.

In ulcers he practices bathing with an emollient and resolvent decoction every four hours.

Finally Chambon says:

"Simple water, harmless, homogenous, analagous to our own juices, is capable, according to Palatins, of healing the largest wounds. What renders this liquid so worthy of recommendation, is not so much its actual qualities as its exemption from the evils which attach to other fluids."

We see by the preceding passages, that it is in the "Memoirs" and "Prize Essays of the Academy of Surgery," we find the germ of the simplification of dressings; and if we must in justice say that surgeons of that period have rather sought to destroy old prejudices and traditions, than to trace new rules for our guidance, we must nevertheless acknowledge that some among them had discovered the advantages of water as an antiphlogistic and *topique* in the treatment of wounds.

Evidently we may say that the Academy of Surgery has given the impulse to the reform which has since taken place in the mode of dressing, and that necessity also has compelled a resort to water, when our military surgeons found themselves deprived of every other means.

Indeed, to Lombard, one of our most celebrated military surgeons, was reserved the honor of establishing a mode of dressing so simple and so advantageous.

In 1786, Lombard published in his *Opuscules de Chirurgie*, a very remarkable article, in which he established the value of a therapeutic agent until then too much neglected, and opened a new road which soon had to be followed by the surgeons of the French armies during the great wars of the revolution, and of the empire. This work, entitled "Summary of the properties of simple water, employed as a topical application in the cure of surgical maladies," is divided into two parts: in the first, he treats of the properties and advantages of cold water; while he devotes the second to the consideration of tepid water and to an examination of the affections and temperaments which demand the use of tepid rather than cold water, and the reverse.

I will give in my second division, many extracts from this highly practical work, which will enable us to appreciate its value.

Percy being at Strasbourg in 1785, as surgeon-major of the regiment of Berry, had an opportunity of seeing the results obtained by Lombard from simple water dressings upon some soldiers wounded in a trial of ordnance. A quick observer, he comprehended immediately all the advantages of this mode of treatment upon the field of battle. We may judge of his opinions

by the following passages, copied from his article entitled "Water," in the "Dictionary of Medical Sciences;" an article which contains in germ nearly all the applications of water which have been made since in the treatment of surgical affections, even irrigations.

"Among the kind of miracles," says he, "which I have seen wrought by water in wounds from fire-arms, I will instance the cure of nearly sixty young volunteers of a battalion called "Louvre," which having left Paris on the first day of December, 1792, was ordered on Christmas day to the assault upon Montagne-Verte, near Treves. The enemy placed upon a height, made upon the battalion a well sustained fire, and most of these young men were wounded in their feet. Many were taken to the military hospital of Sarrelouis, of whom only a few could be saved without amputation. The others remained in the convent of Consarrebruck, with two German surgeons, who were charged with their care. By my advice, and *perhaps in default of other remedies*, the attendants bathed their feet incessantly, and showered them with water moderately cool, covering their wounds with compresses constantly moistened with the same. No other dressings were used, and I attest that only four died, of whom two died of adynamic fever, which disturbed and interrupted the treatment of the wounds with water; one of colliquative diarrhea, and the fourth of trismus. All the others recovered rapidly; several had not even anchylosis, although their feet had been traversed in every direction, complicated with tearing of tendons, aponeuroses and ligaments, and with splintering of the bones, sometimes of the tarsus, sometimes of the metatarsus."

Larrey relates in the following manner the advantages which he derived from the use of water in the campaign in Egypt.

"One would be astonished without doubt, to learn that with a few sea biscuit, a little good water which was carried with each wounded man, and *by the use of brackish water only for their dressings*, a very great number of these individuals, suffering under severe wounds of the head, of the breast, of the abdomen, or deprived of some of their limbs, crossed the deserts, which separate Syria from Egypt, a distance of about sixty leagues, without any accident, and with so much benefit, that most of them found themselves cured when they reached this latter country."

Briot, a very distinguished military surgeon, is much pleased with the employment of water, which he regards as *le vulnérable par excellence*, in the dressing of wounds received upon the field of battle.

"The general method of dressing which we employed," says he, "consisted in doing nothing without a motive. We used with success, and almost

always to the accomplishment of perfect cures, *cold water* in wounds made by small arms; also in cases of stupor, in wounds of tendons, of aponeuroses, of capsules and of membranes; and *tepid water* in those made by fire arms and which were suppurating."

The most notable cases of success resulting from the use of water in gunshot wounds are unquestionably those reported by Dr. Treille, after the battle of Baylen.

"I obtained, seven years ago, the most happy effects from the indiscriminate application of pure water upon every variety of gunshot wounds.

"A very extraordinary circumstance compelled me to employ this means alone. I confess that at first I was not without some solicitude as to the results, but I was quickly reassured by my success. The facts were thus: After the battle of Baylen (Andalusia,) I remained upon the field the only surgeon to take care of five hundred wounded. Deprived of all medicines, I had all the wounds washed with pure water. I continued my dressings in this way during twenty-one days that we remained upon the field of battle, receiving nothing from without but some linen and provisions. As it would have been impossible for me alone to dress five hundred wounded, I arranged them in three sections and dressed one section each day, and they dressed themselves the two other days.

"Only seven or eight wounds became gangrenous, and I had but two cases of tetanus.

"When attention is given to the circumstances in which I was placed, it will be apparent what we ought to think of simple water in the treatment of recent wounds. Here were five hundred wounded lying upon the ground from the nineteenth of June to the tenth of July, (1808,) under the broiling sun of Andalusia, having nothing whatever for shade but the thin branches of olive trees, deprived of the consolatory hope of ever again seeing their own country, and given up to the mercy of the inhabitants of Sierra-Morena, who were all in arms and highly exasperated.

"In a word, the moral as well as the physical was but little favorable to the treatment of wounds; I have shown you, nevertheless, what was my success."

I have had the more pleasure in citing this remarkable passage from the thesis of doctor Treille, because it has been generally overlooked by those who have given attention to the use of water.

In the Dictionary of Samuel Cooper, we find the following passage, which gives the opinion of Guthrie upon the employment of water in gunshot wounds:

"By cold water," says Guthrie, "the inflammation is in certain cases entirely prevented, in many greatly controlled, and in almost all much subdued, whilst the suppurative process is not sufficiently impeded to prevent the subsequent action of granulation. In all simple cases of gunshot wounds, that is to say, wounds which implicate only the soft parts, in persons of a healthy constitution, a little lint dipped in oil, or on which some ointment has been spread, is the best application in the first instance to prevent irritation: supporting the whole with two strips of adhesive plaster laid across. A compress or folds of linen wetted with water are then to be applied over it, and to be kept constantly wet and cold, even by the use of ice, if it can be obtained, and it be found comfortable to the patient."

And a little farther on,

"Cold water is not an infallible remedy; its use is not even always advantageous: there are many persons with whom cold applications do not agree; there are more with whom they disagree after a certain period, and in these two cases they should not be persisted in. Cold does no good at any stage of inflammation when the sensation produced by the first application is disagreeable to the patient, and when it does not sooth; for if it produces a sensation of shivering, or any other uncomfortable feeling, if it causes a stiffness in the part, it is doing harm, and if we change the treatment and cause a genial sensation of warmth in the limb, it will not only prove more comfortable, but be found actually advantageous. This happens in general at the period of the commencement of suppuration; and in such cases cold prevents the complete effect of the suppurative action, which heat favors. Fomentations are then excellent."

Profr. V. Kern, of Vienna, published in 1809 a work in which he recommends tepid water in the treatment of wounds.

Among the authors who have written upon this subject we will mention, in France, M. M. Rouboud, Mauricheau-Beaupre, Laurent, Tanchou, Cloquet, Serre (of Uzes,) Marjolin, Blandin, etc.; in England, Samuel Cooper; in Germany, Dzondi, professor at Halle, Rust, etc.; Mayor, of Lausanne.

We should also mention in a particular manner, Sanson, who writes thus in his article upon "Water" in the "Dictionary of Practical Medicine and Surgery," published in 1831:

"With water," says he, "I have seen cured by first intention, contused wounds, accompanied with more or less laceration and stretching of the parts; I have been able to save most persons upon whom I have practised amputation, or other grave operations, from the fever called traumatic; in-

deed I have been able to cure, without amputation, and even without active inflammation or copious suppuration, many persons having fractured limbs complicated with wounds and projection of the fragments."

The eulogium which Sanson bestows upon water is based upon extensive experience, and it acquires more value when it is known with what cautious reserve this expert surgeon adopts all surgical innovations.

From this historical glance we see that the use of water in surgery has made great advances since the publication of the work of Lombard. During the wars of the Revolution and of the Empire, necessity often compelled surgeons to resort to it, and it is surprising that, seeing the success which attended their practice, it has not come to be generally adopted. Fomentations and affusions, the only methods then employed, although very simple in their application, really efficacious and possessed of all the advantages of cataplasms without their inconveniences, still left much to be desired.

To regulate the application of water upon the surface of the tissues, so that its action may be always precisely the same, by substituting for the hand of man a very simple apparatus, and which requires the least care to ensure a uniformity in the flow and temperature of the liquid, is an improvement for which we are indebted to M. Josse, sen.

The method of continued irrigations which he employed before 1830, at the Hotel Dieu, of Amiens, is one of the most remarkable and useful surgical innovations. In 1834, M. Breschet, at the suggestion of M. Josse, the younger, tried this method at the Hotel Dieu, in Paris, and obtained such success as to attract the attention of surgeons. It is indeed very probable that had the experiment not been made in so large a hospital, and under the auspices of so distinguished a surgeon, its use would have been yet for a long time confined to the patients in the Hotel Dieu, at Amiens.

At this period Doctor Rognetta made known in an able article, the two first successful experiments of Breschet, and also the apparatus employed.

In 1835, M. Josse, the younger, published in his "Miscellanies of Surgical Practice," the method employed by his father for seven years. The practical illustrations contained in this work and the physiological suggestions which the author has added, have enabled practitioners to estimate at their true value the advantages which may be obtained from this new mode of treatment.

The same year Augustus Berard presented, in the "General Archives of Medicine," a "Memoir upon the employment of cold water as an antiphlogistic in the treatment of surgical maladies." This work contains an expla-

nation of the process employed by this distinguished surgeon for irrigations, and some very interesting observations upon his success in the use of this means, to which he had more or less resorted since 1833.

Since then many practitioners have adopted its use; among many others, the theses of M. M. Boudrie, Omouton, Roger, Martineau, Ichon, Roberty, Delamotte, Laden, Gravis, Gueury, presented to the Faculty of Medicine, of Paris, the works of M. M. Christophe, Godin, Nivet, Phillips of Liege, inserted in the periodical reviews, the able chapter which M. Denonvilliers has devoted to this subject in the "Compendium of Practical Surgery," have enriched science with new facts, and important practical suggestions.

M. Baudens, ever partial to the traditions of military surgery, and to the principles of Lombard, of Percy, of Larrey, of Treille, and of Guthrie, thus speaks in his "Treatise upon gunshot wounds," in relation to his own practice since the commencement of the African campaign:

"The dressings of wounds should be as mild as possible; such as perforated linen smeared with cerate, lint, compresses and rollers. These dressings should be wet with cold water constantly for several days."

Since then M. Baudens has always professed the same doctrines that he taught in his book; he has even gone farther, for he employs now ice and refrigerant mixtures with success. But we must not forget that beside great experience in the use of this therapeutic means, the surgeon of Val-de-Grace had generally *only strong and robust young men to treat*, and we shall understand how he could be so successful with an agent at once so powerful, and, as we think, so dangerous.

In his "Operative Surgery," (2d ed., 1839,) M. Velpeau, after having enumerated the objections alleged against irrigations, closes as follows: "I think I can predict, after what I have seen, that irrigations will not continue to be used except as an occasional modification of the dressings and in a small number of cases."

It is to be regretted that M. Velpeau has shown himself so little favorable to irrigations. Indeed, his clinical teachings, sustained by his high position, have without doubt contributed more than any thing else to arrest the progress of this new therapeutic means.

In 1839, our worthy *confrere*, M. Lacorbiere, issued his learned "Treatise upon cold," employed both externally and internally "as a hygienic, medical and surgical agent." In this work, the most complete which our science possesses upon this subject, the author sustains with great justness of argument, supported by numerous facts, all the advantages which had been claimed for cold water in surgical affections. In a letter addressed to

M. Lacorbiere, and published in his work, M. Alquié declares in these words his opinion upon the use of water:—

“I have under a multitude of circumstances,” says he, “derived advantages, *almost marvelous*, from the action of cold water, and from ice in cases of severe traumatic lesions. In 1823, when I directed the medico-chirurgical service of the hospital of Perthus, I attributed to this means the cure of several gun-shot wounds situated in the feet and hands. In the case of a drummer of the eighth regiment of voltigeurs, whose right foot had been traversed by a ball, breaking the first cuneiforme and producing great disturbance of the parts, I could only avoid serious accidents by the diligent application of cold water to the wounded member.

“Especially in large contused wounds has this means been useful. When I was surgeon major of the sixth regiment of dragoons, a captain of this regiment, M. David, received at Pontivy a kick from a horse upon the middle of his right leg. A large wound, four inches in length, resulted from the tearing of the inner half of the gemellus and the integuments. The periosteum along a portion of the tibia had been scratched by the iron, which had made an indentation in the inner side of the bone; it was a horrible wound! Ice water applied continuously during sixty hours, prevented completely all immoderate inflammatory action, and this extensive solution of continuity united almost without suppuration. It appeared that we had the power to regulate the inflammation precisely to the condition necessary for re-union.”

I could cite similar cases which occurred among the dragoons of the sixth regiment, and several others at the hospital of Toulon and of Alger.

In 1841, Mathias Mayor, in his “Surgery simplified,” writes thus:—“Water has been invoked and proclaimed in every age and by the greatest surgeons, as the most important agent in the treatment of most surgical affections, and as the means, *par excellence*, to favor the efforts of nature. It is to be regretted that this opinion so prevalent among surgeons and physicians has had so little influence with the people, and especially with military men.

“Water applied under the form of baths, and baths much prolonged, so that a part seriously injured is kept constantly cool, produces most generally effects which we shall in vain seek to obtain from any other therapeutic agent.”

In this book M. Mayor discloses the new method of local and prolonged baths suggested by his son, and the *appareil* which he invented for their application. The idea of prolonged baths in the treatment of surgical affec-

tions can be traced back to Lamorier; nevertheless we ought to give credit to M. Charles Mayor for having introduced this mode, and for having conceived ingenious apparatus for its application.

In 1842, M. Malgaigne presented to the concours of the surgical clinique of the Faculty of Medicine of Paris, a thesis upon "irrigation in surgical affections." This truly excellent work winds up with the following conclusions:

"First, cold irrigations are an excellent antiphlogistic when employed in superficial wounds or inflammations; but even then they are not infallible, whilst in deeper wounds and inflammations they only mask the symptoms, and ought to be rejected.

"Second, continued irrigations are only suitable for the hands and feet, and perhaps also the forearm, but my facts are not sufficient upon this last point to decide; and even in these regions recourse should not be had to them except in the most severe cases. I give them an almost absolute preference in gun-shot wounds, but for other wounds I prefer intermittent irrigations.

"Third, in all cases the parts undergoing irrigation should be carefully covered with compresses, so as to exclude the air.

"Fourth, simple water appears preferable for continued irrigations, but for intermittent irrigations I choose *eau blanche* (plumbi diacetatas, &c.) in cases of wounds, and a solution of sulphate of copper or wine in cases where no wound exists.

"Fifth, the temperature must *vary* according to the sensations experienced by the patient when the water is first applied: and in all cases we must abridge the duration of the irrigations as much as possible."

I believe with M. Malgaigne, that irrigations are not absolutely infallible any more than other means employed in surgery: but, with the numerous facts which I possess of lesions located in almost every part of the body forearm, leg and knee, I cannot agree with him in the limits which he has placed upon its use. As to the duration of the irrigations, I think, where a moderate temperature is suitable, they may be continued a long time with advantage, and I am reminded among others, of a case, which I will soon publish, where a cure was effected of a severe wound of the leg, by irrigations of water at a temperature of 20° C. (68° F.) continued more than two months.

In 1844, M. Nelaton, speaking of the treatment of contused wounds, in his "Elements of Surgical Pathology," thus expresses himself: "We have before said that cold irrigations are useful in the treatment of contused

wounds; they are especially useful in wounds of the extremities, complicated with crushing of the bones and laceration of the soft parts.

"The treatment of wounds by the continued action of cold water claims the highest antiquity; Hippocrates, Galen, and Celsus have all spoken favorably of it. In our day several eminent practitioners have made similar trials, and with similar success. The eulogiums which MM. A. Berard, Sanson, Breschet, Velpeau and Josse bestowed upon it, have contributed to its extension, yet it is still far from being generally adopted. Cold water has not always been employed in the same manner in the treatment of wounds; sometimes there is applied upon the wounds one or several compresses dipped in this liquid; and when they begin to become warm they are renewed, or dipped again in cold water. This method exposes the part to alternations of heat and cold, either by a complete omission to renew the cloths, or by their not being renewed sufficiently often: this method has therefore been abandoned, and continued irrigations with cold water have been substituted.

"I have seen, in the service of MM. Breschet and Sanson, irrigations continued ten, fifteen, twenty days, and even a month, for the gravest articular wounds, and for the most complicated fractures. In many cases I have seen complete restoration, and never have I seen serious accidents supervene which could be charged to the irrigations.

"Nevertheless, in spite of its advantages, permanent irrigation with cold water cannot be employed as a general method of treatment. All who have employed it regard it as an exceptional method, especially applicable to contused wounds, and more especially to wounds complicated with fracture, where, in the case of the upper extremity, the injury is not above the elbow, and in the case of the lower extremity, not above the knee.

"M.M. Breschet, A. Berard, and Pinel Grandchamp have substituted tepid water for cold in irrigation, and the results have been generally satisfactory."

In 1847, M. Richet presented to the concours *pour l'aggregation*, the surgical section, a thesis upon the employment of cold and heat in the treatment of surgical affections. In this excellent treatise, which answers perfectly to its title, the author discusses carefully the advantages and the inconveniences of cold and of heat; we have derived from it some very valuable information, both historical and practical.

Having completed this historical sketch upon the surgical employment of water, I will dwell a moment upon hydrotherapia. Two distinguished practitioners, MM. Scoutteten and Schedel, have published two important works upon this subject, which will enable us to judge of its merits.

This system, founded, as they say by a simple peasant of Silesia—Priesnitz—already reckons so great a number of partizans, that there is not a country in Europe where we do not find hydropathic establishments. Priesnitz began by applying fomentations and baths to surgical affections, such as sprains, fractures, slight wounds, and the results seemed to him so marvelous, that he proceeded to extend its use, by applying it in most affections, internal as well as external. One of his first cures was made upon himself. In the season of hay-making, says M. Scoutteten, he was kicked by a horse, which throwing him down, and the wagon passing over him, broke two of his ribs. The accident was so serious that the surgeons thought he would be maimed for life. Priesnitz disputed their judgment, and determined to treat himself; the consequence was, he perfectly recovered.

Since then, hydiatic means have been applied with success in a great number of analagous cases, and very recently Dr. Fleury has published a statement of the uterine diseases successfully treated by this method.

If now we examine the different modes of dressing which are used in the hospitals of Paris, we shall find that cataplasms of flour, linseed, linen spread with cerate, etc., constitute almost the only means in cases of wounds and contusions of every kind. If cold water irrigations are sometimes resorted to, it is only as an exception, yet I have myself seen cases of comminuted fractures, wounds, simple and contused, felons, &c., in which the application of water would have proved serviceable in the reduction of inflammation, to say nothing of its effect upon the pain, which is certainly abated, and often destroyed by simple water dressings; a result which cannot in the same degree be obtained from cataplasms and the other modes of dressing.

Yet I acknowledge that M. Baudens, of Val de-Grace makes continued applications of refrigerant mixtures, or of ice and simple cold water in most traumatic lesions, and after a great number of operations. M. H. Larrey, surgeon-in-chief of the hospital of Gros-Caillou, also uses irrigations frequently.

In private practice, in the city of Paris, this means is proportionably more employed than in the hospitals. My father resorts to it constantly in the wounds and complicated fractures which he has to treat; during the last few years, especially, he has generally used water in most surgical affections, and after operations.

As to the practice of foreign surgeons, my information is not sufficient to enable me to speak positively: I know, however, that in the hospital of the University of London, nearly all the dressings are made with simple water.

I believe the use of simple water in irrigation is quite common in the provincial towns of France. It is used with success by M. le Clerc of Saint-Germain, M. Guyot of Rennes, M. Fontan of Niort, M. Maher of Lorient, MM. Chaumette and Erigohen of Bordeaux, M. Rigal of Gaillac, M. Villepin of Compiègne, M. Patry, etc., etc.

HISTORICAL SUMMARY.

It will not perhaps be uninteresting to review, in the briefest possible manner, the successive phases through which the use of water in surgery has passed.

In the first periods of the world water must have been almost universally employed, because of its simplicity.

Hippocrates, Celsus, and Galen have all assigned to water a most important place in hygiene and medicine, and have recommended it also in a great number of surgical affections.

In the middle ages, powders, ointments, plasters, miraculous and charmed waters, were too much in favor, and their use was too much in accordance with the general spirit of the age, for a remedy so simple to possess any credit with either physicians or their patients. At a period somewhat later, Fallopius, Ambrose Pare, Martel, &c., endeavored to introduce the use of water, and to separate it from superstitious practices.

In modern times, Theden, and especially Lamorier, sought to attract the attention of their cotemporaries to an agent which had been so successful in their own hands, but without being able to secure for it fairly a place in surgical therapeutics.

The Academy of Surgery, which has furnished so many valuable works upon most surgical diseases, has especially endeavored to simplify dressings, and it would seem that to the accomplishment of this end they would naturally have urged the use of water, inasmuch as it would effectually and advantageously have replaced all those agents whose abuse and use even, it desired to abolish.

It is true, as the passages which we have quoted from the memoirs and prize essays of this learned Society abundantly prove, that some of its surgeons appreciated the value of water, but they did not sufficiently insist upon its advantages to command attention. So evident is this, that not one author who has since written upon this subject has referred to the writers of that period, a period so glorious for French surgery.

Lombard, by indicating precise rules for the employment of water in surgery, in a work published in 1786, may be regarded as the founder of this

new practice. The period was moreover very favorable for its introduction; the necessities of war compelled surgeons to employ this liquid under circumstances where nothing else could be procured, and we are astonished after seeing the results that were obtained by Percy, Larrey, Treille, &c., that the use of water did not from this time become general. Still its reputation has been progressive, and we can see that water was in much more universal use at the beginning of the present century, than in the preceding centuries.

When the attention of surgeons was attracted to irrigations by the works of M. Josse and A. Berard, published in 1835, as also by the success of MM. Breschet, J. Cloquet, &c., a great many other surgeons resorted to it, and it attained a temporary popularity. But gradually, through the influence of old habits, and perhaps also on account of the care and attention which the use of water demands, and especially on account of the occasional accidents resulting from the *cold*, this powerful agent has been neglected until, as we have remarked, its employment in the Parisian hospitals is only exceptional.

Very recently, also, I have visited the hospitals of Lyons, Bordeaux and Geneva, and I have found but few exceptions to the common mode of dressings, such as is practised here, and generally elsewhere. The same is true even at the hospital of Lausanne, where resided the elder and the younger Mayor, who next to Josse, father and son, have more eulogized the topical application of water, than any other person.

Finally, the great number of water establishments which actually exist in Europe, and in which water is systematized through all its forms in the treatment of surgical diseases, the hospital of the University of London, where all the dressings are moistened with this liquid, encourage a hope, that at no distant day this therapeutic agent will occupy the first place in surgery as a topical antiphlogistic.

CHAP. II.

GENERAL CONSIDERATIONS UPON THE USE OF WATER.

In the first chapter of this work, I have collated all the historical documents which I could procure, on the use of water in surgery.

In this second chapter I shall enter upon the practical part of my subject, and I shall examine the following questions:

1. What kind of water ought to be used in surgery?
2. What are the effects of water at different temperatures?
3. What, in general, is the most suitable temperature?
4. How long ought the water to be continued?
5. What are the advantages of the use of water at a suitable temperature?

6. What are the inconveniences which have been attributed to this agent?

After this general examination, I will describe in the following chapter the principal modes which have been indicated for the application of water.

1. *What kind of water ought to be used in surgery.*

We may employ every kind of *fresh* water, and consequently that which is most easily to be procured; but if we have our choice, we should prefer such water as contains the smallest quantity of saline and foreign particles

Earthy and saline waters, when long continued, deposite upon the epidermis much salts, which form a kind of adherent crust, as we have lately noticed in the case of a lady whom we submitted, for more than two months, to continued irrigations with tepid well-water, for a fracture of the leg with a large wound and gangrene of the integuments.

2 *What are the effects of water at different temperatures?*

Cold water, that is, from 10° down to 0° C, (50° to 32° F,) or to the freezing point, applied continuously upon inflamed parts, is a powerful antiphlogistic and sedative, when the patients can support it without inconvenience. It abates the morbid local heat, and subdues the inflammation, one of whose chief elements is now removed; it determines in the tissues, at the point of its application a fibrillary contractility, which constricts the structures, and augments, so to speak, their cohesion; it possesses, then, a very decided astringent property. By diminishing the calibre of the capillaries it repels the blood and becomes repercussive. These properties have often been put to profit in arresting hemorrhages, and in diminishing the too great laxity of the skin in certain parts, as in the superior palpebræ, scrotum, &c.

Cold water has also the property of directly exciting the tissues, and with an energy proportioned to the lowness of the temperature, and the suddenness of the impression. We may invoke this property of cold water advantageously, in all cases of atony, and of debility of any part of the system, to arouse action and to restore the tissues to the condition of excitement necessary to cicatrization.

M. Pirogoff affirms that "there is no better means than the employment of ice or snow, to combat the scorbutic tendency which a low temperature impresses upon wounds during the rigorous winters, so common in Russia." "I do not know," says M. Richet, from whom I borrowed this passage, "whether the Russian surgeon applies the cold intermittently; yet in this way alone can I explain its efficacy, by supposing its success to depend upon the reaction which always results from its sudden application and removal."

I think, with M. Richet, that it is by the momentary application of very cold water upon the surface of the tissues, securing thus its stimulating properties, that M. Pirogoff obtains his success in all the cases above alluded to.

The surgeons who have used cold water most, have constantly noticed a depression of the temperature of the skin; but no precise experiments have been made to ascertain whether there was an equilibrium of temperature between the liquid and the skin.

What has been said of cold water, is yet more manifestly true of ice and of freezing mixtures.

"The mode of action of cold water," says Lombard, "being known by daily experience upon sound parts, it is easy to understand what must be its effects upon wounds in general; and it is proper to say, that during the access of the inflammation, to which contused and lacerated wounds are principally subject, it is absolutely necessary to repeat the application often to prevent *the increase of heat and the desiccation*. The coolness of the water also, while it tempers the heat, obviates congestions in the affected vessels. Consequently the suppuration is infinitely less and more prompt as the following history will prove.

"Christophe Hebert, a fusileer in the regiment of Alsace, company of Ruttenburg, aged about twenty years, of a delicate temperament, received the 9th of February, 1785, a cut from a knife which severed the extensor tendons transversely, and also the metacarpal bones which sustained the three last fingers. He was immediately taken to the hospital.

"The mode of dressing consisted in placing the hand upon a pallet, so that, by the aid of a crucial bandage, we could retain the fingers in place after they had been adjusted. This appareil was simply moistened with cold water, with express injunctions to renew it as often as the patient discovered in the limb a certain degree of heat. The hæmorrhage, although quite copious at first, soon ceased. On the third day, the hand was a little swollen, but the pain was so slight as not in the least to discompose him, or disturb his sleep, and the wound had such a healthy secretion, as to permit us to regard the swelling as of no consequence. Suppuration progressed regularly without becoming excessive, and was at all times healthy. The dry lint, employed in the last dressings, completed the cicatrization which the continued use of cold water had so well commenced, and the soldier left the hospital on the 19th of March, perfectly cured, and without having experienced a single unfavorable symptom."

Cold water possesses very marked stimulating properties; it congests and reddens healthy tissues, and it produces the same phenomena upon inflamed parts. It also hastens suppuration.

At the temperature of 30° to 35° C, (86° to 95° F,) that is to say, below and near that of the body, its application upon an inflamed part, where pain, heat, swelling, and redness are present, relaxes the tissues, obtunds their excessive sensibility and contractility, and in a word, produces marked relief. If the application is continued, the cortege of inflammatory symptoms are seen little by little to disappear, and its emollient action is exhibited in the most favorable manner. At this temperature, also, it promotes suppuration. We see indeed every day, wounds whose appearance was satisfactory, and

which had reached the stage of regular suppuration, suddenly assume, under the operation of various causes, a bad aspect, in connection ordinarily with a manifest diminution, and sometimes with an arrest of the secretion of pus. In these cases the employment of water moderately warm soon restores the secreting surfaces to their normal conditions.

Water, at a middle temperature, that is to say between 18° and 25° C, (64° and 77° F,) partakes of the properties of cold water and of warm. At this temperature it has almost all the advantages of cold water without its inconveniences, as we shall hereafter consider.

Its use, after an operation, destroys the erethism and the pain which ordinarily succeeds; if on the contrary, the patient is in that state of stupor which usually accompanies grave lesions, such as violent falls, crushing by machines, wounds from fire-arm, &c., it restores tranquillity by regulating the action of the nervous system.

In cases where inflammation has not yet occurred, it prevents it, and often obviates the development of traumatic fever. If, however, these phenomena are already manifest, water moderates them, or makes them entirely cease, and arrests the accidents which the inflammation has produced. In short, its local effect seems to be to diminish the tendency of innervation to determine to one point all the elements of inflammation.

I have witnessed the power of continued irrigations of tepid water, in subduing traumatic fever, consequent upon a very severe operation made by my father upon a lady sixty years old. Water at 20° or 22° C, (68° or 71° F,) employed immediately after the operation had prevented all inflammatory reaction, when the patient suspended the application during the night. Fever was soon apparent. After several hours the irrigations were recommenced, and the fever ceased. Again the water was suspended and the fever reappeared, and again applied and it disappeared.

In the treatment of simple wounds, water favors greatly union by first intention, as has been already noticed by A. Berard.

If we carefully note the action of water upon a suppurating surface, we see that it acts as an antiphlogistic and deterative. It moderates the purulent secretion and removes the pus as fast as it is produced. Indeed we may affirm, that from the use of this agent there results a suppuration laudable in quality and in quantity; also an inodular membrane, and by consequence, a cicatrix, formed with more regularity and promptness.

How does water produce the effects of which we have spoken?

Is it by restraining the morbid development of caloric in the part?
(Martel, Parr, Josse.)

Is it by a hyposthenic action upon the nervous radicals?

Is it by absorption, as Louis, Percy and Lombard think, in opposition to M. M. Josse and Malgaigne?

Is it because water by irrigation acts upon the parts as a bath of moderate temperature, which, while it does not interrupt the circulation of the fluids, prevents nevertheless their being carried in too great abundance to the diseased limb? (Nivet.)

Is it by maintaining in the diseased parts a uniformity of temperature, that the cataplasms and warm or hot water dressings of Mr. Liston act, producing an incubation of a novel kind? (Richet.)

Is there a developement of electric phenomena, from the contact of the water with the body at unequal temperatures? (Josse.)

The subtraction of morbid caloric, and the depression of the temperature upon the surface where the water is in contact with our bodies, are phenomena which we understand. But as to the other questions, they are yet in a state of hypothesis; nevertheless, I am inclined to think that they also have some connection with the truly marvelous effects produced by water.

Relative to absorption, the following experiments, made by M. Patry, incline us to admit it as an explanation, at least under some circumstances. "To determine," says he, "the *modus operandi* of cold water there is an experiment which I have many times repeated: If we apply a vesicatory, and remove it when rubefaction is produced, water, upon first contact with the inflamed skin, determines a painful and smarting sensation; but soon the pain is blunted, the sensation of burning heat diminishes and at length ceases entirely. If we suddenly suspend the application of the liquid, the inflammation is promptly renewed, and with more violence than at first; for the vascular ramifications having become more permeable admit now a larger quantity of blood. Again, if we remove the vesicatory when the vesicles have begun to form, we see them diminish and even completely disappear some hours after the application of cold water. If we suddenly cease the application, the vesicles are soon seen to be reproduced and to augment in volume. This fact demonstrates that the physiological action of absorption is not retarded by cold water applied to the surface of wounds.

"To the patient who was the subject of the first observation, I have several times applied three centigrammes of sulphate of morphia upon the surface of the wound during continued irrigation; soon he has become drowsy. The following day I have substituted ten centigrammes of tartrate of antimony for the morphine, and the patient has experienced nausea without vomiting.

"A woman complained of a very severe rheumatic pain, seated in the deltoid muscle. Several blisters had been in vain applied upon the painful spot. The epidermis was removed after the last blister, and the raw surface sprinkled with three centigrammes of morphine, and then covered over with wet lint; the lint was constantly moistened. Night and morning the morphine was renewed, and the fourth day the pain had completely gone.

"These facts prove, beyond controversy, that the application of cold water to the surface of a wound, does not hinder absorption. We should, nevertheless, take care when desiring the absorption of a remedy, not to pour upon the part an excess of water, for, whether soluble or not, it will be washed off.

"If we remove the vesicatory when the cuticle is already very much raised, absorption will not take place, however long the water may be applied.

"Upon all the patients, whose cases I have cited in this memoir, I have established the action of absorption by the application of cold water to the surface of the wound."

Malgaigne, after having recalled the different theories which have been devised to explain the action of irrigations, says:

"Without engaging in a discussion which is scarcely susceptible of an entirely satisfactory termination, I will say that in my opinion, the only way of comprehending the therapeutic action of an antiphlogistic, is to recognize in inflammation several elements, according to the doctrine of Berard and Barthéz. If we attack one of these elements before the inflammation is developed, frequently it is entirely prevented; if after it is established, the success will depend upon the relative value of the element attacked, and of the stage at which the inflammation has arrived. Thus opium in large doses, by subduing the pain, obviates phlogosis; while leeches act by diverting the sanguinary afflux.

"So by cold irrigations, in whatever way applied, we combat directly, either before or after their appearance, the heat, the sanguinary afflux, &c. With certain subjects, however, other elements predominate, as for example, the nervous element or pain, then cold irrigations are powerless, *and it becomes necessary to resort to tepid liquids.*"

3. *What, in general, is the most suitable temperature?*

This question, which addresses itself to every surgeon who resorts to the therapeutic agent of which we speak, is far from being definitely answered; it even appears to me that the ancients had a better appreciation of the value

of temperature than the moderns, for they recommended that the water should be warm in winter and cold in summer, yet this generally had reference to affusions or fomentations, whose action is less powerful than irrigations and immersions.

"Cold is severe upon wounds," says Hippocrates; "it hardens the skin, excites pain, retards suppuration, predisposes to gangrene, shiverings, convulsions, tetanus."

The ancient school, imbued with these principles, showed itself in general more favorable to the employment of water at a mild temperature, and even warm rather than cold.

If we refer to the historical part of this work, we shall observe that A. Pare, Lamorier, Louis, Pontier, Guyot, Recollin, and Chambou generally gave the preference to tepid water.

Lombard, who has studied with care the differential action of water in the treatment of a great number of surgical affections, thus expresses himself: "The varieties of which diseases are susceptible, according to the person affected; the different conditions into which they pass successively, depending upon the age, the time, the season and the place; the parts more or less delicate which are involved, etc., are circumstances which do not permit the supposition that cold water can be a remedy applicable to every kind of injury.

"Such are the general properties of tepid water, that it softens the tissue of the skin, relaxes the texture of the nerves which are distributed through it, and dilates the pores and prepares them to receive the smaller particles of water, to be afterwards carried along in the course of the circulation. These various effects, contrasted with those invariably produced by cold water or ice, teach us the necessity of managing these topical applications according to the relative indications.

"In no way can we combat inflammation more effectually, in no way can we relieve the maladies of persons of a dried-up constitution, and especially of old men, whose fibres are stiff and withered, than by baths, fomentations, immersions, and ablutions of tepid water. The true and only remedy is, to preserve the flexibility and the action of the fibres, by moistening them as often as possible.

"The most skillful practitioners of the last centuries did not confound the properties of cold water with those of warm. The proper time for employing this remedy, cold or warm, was indicated by the changes which occurred in the wounds, and by the different revolutions which each season brought with it. The modifications of heat and of cold, of which water is

susceptible, seemed to fulfill all indications. *The degree of heat at which they ordinarily employed water, was such as would excite an agreeable sensation when the hand was plunged into it.* This is what Pare intends when he says that it ought to be temperate or tepid."

In support of these ideas, the author cites the following facts:

"Two days," says he, "after the entrance of the soldier from Alsace into the hospital, there presented himself a corporal of the regiment of Foix, company of La Richardiere, named Guirdin, wounded by a thrust from the point of a sabre, which traversed the thickest part of the deltoid. This man was of a bilious complexion, and had a very irritable fibre. The excessive tumefaction which occurred in the shoulder, the moment the wound was received, indicated an effusion in the track through which the sabre had passed. To evacuate the blood, I enlarged the posterier opening, whose narrowness did not permit it to escape. This done, I had the tumor fomented with *warm water*, and soon it was diminished more than half, the blood having escaped freely from under the gentle warmth maintained by the fomentations. The track closed gradually, with slight suppuration, and the two wounds cicatrized promptly. The progress of cure was steady and uninterrupted, and the patient resumed his military exercises on the twenty-fourth of March.

"The twentieth of April following, two fusileers of the regiment of Hesse Darmstadt, entered the hospital, wounded by blows inflicted for desertion. One of them, twenty-two years old, was of a humid temperament, and had a very loose fibre; the other, in his thirty-eighth year, was, on the contrary, of a robust constitution, bilious and dry.

"The first, Jean H——, was constantly dressed with *cold water*, and was cured on the ninth day, although the integuments had been lacerated very deeply in several places.

"The second, Christophe A——, was fomented with *warm water*: and notwithstanding he had been more injured than the first, he was entirely cured on the tenth day."

Lombard has, as we see, endeavored to ascertain the difference in the effects of cold and tepid water.

I partake of his opinion and of that of A. Pare, as to the estimate we should place upon tepid water, and to this I have been led by observing the cases occurring in the practice of my father, which, while they demonstrate how easily cures are effected with tepid water, which is exempt from the inconveniences charged to cold, furnish proofs at the same time that tepid water should be generally employed.

Percy, Briot, Guthrie, &c., employed according to circumstances, either cold or tepid water: but as they used it generally upon the field of battle, with great numbers of wounded to dress, and destitute often of the most necessary conveniences, they resorted more frequently to cold water, because it was most easily obtained.

"Tepid water," says Sanson, "possesses especially emollient properties in an eminent degree: applied to the healthy tissues, it is promptly absorbed by them, swelling and softening them, without attracting the blood, so that they are left pale and colorless; applied to inflamed tissues, it relaxes them, and *perhaps by facilitating the circulation of the accumulated blood*, it assuages the pain and hastens resolution. It acts as a cataplasm, or rather, as the advocates of water say, cataplasms act as curative agents only by virtue of the water which they contain, while simple water possesses the advantage over cataplasms of being more readily absorbed, since it does not form upon the skin a mucilaginous layer which obstructs absorption; it undergoes no change: it is less cumbersome, less expensive, it is found everywhere, and is subject to this one inconvenience alone which does not belong to cataplasms, namely, it must be more frequently renewed."

Most surgeons who have advocated water as a means to combat inflammation, have generally used it cold, partly because they considered morbid heat as the element especially dominant in inflammation, and partly because it was more easily obtained; and it is but just to say, that success has attended, and will often continue to attend, this mode of treatment.

Nevertheless, when we analyze the ill effects which have been charged to the use of water in surgery, we can not fail to be convinced that they apply properly not against the liquid itself, but against the too low temperature at which it has been habitually used.

If, then, we can abstract morbid heat, and subdue inflammation with water at a temperature agreeable to the patient, that is near, yet generally below the temperature of the body, as well as with cold water, we are, I hope, prepared to admit that cold water ought to be employed only as the exception.

However, it will be easily understood that the use of water at this medium temperature, which varies generally from 18° to 25° C. (64° to 77° F.) depends upon the constitution of the patient, the condition in which he is found, the season, the climate, &c. Water at 15° C. (59° F.) appears warm in summer to a sanguine, robust man, suffering under a violent fever, while it will be cold to a nervous debilitated female, or to an infant. We see then at once, that in establishing as a general rule for temperature, the sensations

of the patient, we have a thermometer preferable to every other; we can now vary the temperature according to a multitude of particular indications, and thus avail ourselves of all the advantages of water without any of its inconveniences. Such has been the rule of practice adopted by my father and myself, and to the present time we have had no reason to be dissatisfied with it.

I have dwelt the longer upon the question of temperature, because I think it essential to the future reputation of water in surgical therapeutics.

4th. *How long ought the water to be continued?*

The duration of the local application of water will vary not only according to the mode in which it is applied, but also according to the judgment of different surgeons.

Water having been generally employed cold, and under the appellation of an antiphlogistic, its use has been suspended when the inflammation was subdued, and there existed, no farther probability of its return.

At the hospital of the University of London, water, which is considered as an antiphlogistic, and also as the best topical application in most of the sequences of inflammation, is employed generally during all the treatment.

Since the success of Priessnitz, cold water constitutes the burden of the whole treatment of all the patients in hydropathic establishments.

I think, with my father, that water, employed in an appropriate manner and according to the different modes which I shall hereafter describe, is alone sufficient for a great number of surgical maladies from the beginning to the cure.

5th. *What are the advantages of the use of water at a suitable temperature?*

We may regard water as the most powerful of all local antiphlogistics, and by proper variations in temperature and in modes of application, it may be rendered sedative, emollient, excitent, astringent, repercussive, &c.

It offers the farther advantage of diffusing and carrying off secretions which excoriate the tissues, or which, by infiltrating into their structure, often caused disorganization and death.

By maintaining in the wounds an inflammation which does not exceed proper limits, and by removing the pus as fast as it is formed, it favors union by first intention in simple wounds, and in many cases it obviates that excessive secretion of pus which exhausts the patients; it also prevents purulent absorption, hospital gangrene, &c.

Properly applied, it maintains the parts at a uniform temperature, which circumstance goes far toward the accomplishment of a cure.

"One of the principal advantages of simple water over other dressings in common use, such as compound fomentations, cataplasms, and unguents, is its cleanliness, which contributes not a little to the cure. For to render the use of water still more efficacious, it is proper, each time the dressings are renewed, to wipe gently the part with a piece of soft and dry lint. This is considered a point of great importance among skillful surgeons." (Lombard.)

Employed upon a grand scale, in the wards of hospitals, for example, it would prevent the development of those mephitic gases produced by the fermentation of pus, and whose influence is pernicious to the sick.

To all these considerations I will add one more, which is a natural sequence to the superiority of water as a therapeutic agent, to wit, we may nourish our patients at a much earlier period than usual. Finally, I hasten to say, that modern surgery has abandoned the practice of *absolute diet*, which, by enfeebling the system beyond measure, places it in the most favorable condition for purulent absorption, as has been well demonstrated by Majendie.

If I have been able skillfully to present my subject in all its bearings, it will have been seen, I trust, how much preferable, in every class of diseases, and in every point of view, are the improved water-dressings to those now generally in use, and the large number of facts, which can not be published in this memoir, will hereafter be found to sustain this proposition.

I must, nevertheless, be permitted to introduce the opinion of M. Sedillot upon dressings after amputations, because it accords entirely with that to which my own careful investigations have brought me, as to the necessity of simplifying dressings.

In a valuable article on the "*means of insuring success after amputation of limbs*," M. Sedillot thus speaks:

"The dressings, in consequence of the grave accidents to which they give rise, are one of the great causes of the mortality of amputations. The stump is strangulated by unyielding rollers, and the wound by straps and sutures.

"The fluids, blood, serum and pus, imprisoned within the wound, compress the flesh, prevent free circulation, induce œdema, swelling, inflammation, erysipelas, purulent deposits, ulceration, phlebitis, erosions of veins, *pyœmie*, caries and necrosis of the bones, etc. Let every surgeon recall his own experience, and answer, whether at the removal of the first dressing he

has not seen the skin œdematous, covered with phlyctenulae in the intervals between the adhesive straps, attacked with an erysipelatous redness, a sanious and fetid pus flowing from the interior of the stump, and all the patients expressing marked relief after the dressing. Who has not been a witness of wounds united almost through their whole extent, in which it became necessary to open them to allow pus, collected in narrow fistulas and large depots, to escape? What abscesses and purulent channels have retarded the healing! What caries and necrosis have indefinitely deferred the cure! Such too frequently are the facts, as may be easily verified in all hospital services: and it is no longer a matter of surprise that physicians are disposed to renew their dressings often in order to save their patients from such severe accidents. I certainly think, if we are to employ dressings at all, it is better to remove them at about twenty-four hours, and assure ourselves of the condition of the stump, rather than wait four or five days in complete ignorance of the state of the wound; but it must be remembered that the renewal of dressings is in itself fatiguing, painful, exposes to cold, and consequently to tetanus; it requires much time, and must be confided to assistants whose experience does not equal their zeal. While they remain upon the wound, a hemorrhage can not be immediately discovered. The amputated limb is either too much or too little compressed, the bandages are relaxed, the flesh is not sufficiently supported, the muscles retract, and in spite of the perfection of the operative maneuver, the bone protrudes, dries, and the life of the patient is endangered.

“A bandage, however well applied, is a feeble measure against the evils of which we have spoken, and the remedy must be more energetic and more complete. If we admit that dressings, whether removed often or seldom, aggravate the dangers, the question is settled: they ought at once to be abandoned. How to dispense with dressings may appear incomprehensible to physicians educated to respect the pledget and the bandage, yet this is a reform which we have adopted, and to which we ascribe our success. But how shall we prevent retraction of the muscles, conicity of the stump, and obtain a cicatrization of the wound? By a means both simple and of easy execution. Dressings are only intended to maintain mechanically in contact, the edges of the wound. If the edges will remain spontaneously in contact, then the dressings are useless, and this is the end which we propose to attain by abandoning the circular amputation, and resorting to a method of one anterior flap, comprising two thirds of the circumference of the limb. The last third is cut perpendicularly from the angle of the flap; the bone is exposed more or less, according to the indications, and the

flap falling back naturally upon the wound, by its own weight covers and closes it, without the absolute necessity of any dressing whatever.

"A linen cloth folded double, and of about two fingers breadth, dipped in some digestive, is applied to the end of the bone in such a way as to constitute a central canal for the escape of the liquids. Two pins stitch and hold in apposition the angles of the flap, until inflammatory induration has commenced, so as to secure union by first intention upon each side, without the retention of pus, for the removal of the piece of lint from the center, about the third or fourth day, leaves a vertical cavity in which blood, serum, and pus can not accumulate. The stump remains naked, exposed to the eye of the surgeon; and the slightest accidents are at once perceived and submitted to proper treatment; if we wish to apply cold or heat, the wound is always accessable, and may be at pleasure covered with ice or cotton. Fomentations made with square pieces of carded wool, lotions, embrocations, frictions, injections, &c., can be easily employed. The pus diffused upon the diaper cloths, (*drap d' alize*,) does not become offensive, and in case the limb is affected with spasms, it can be confined with a handkerchief, or any other piece of cloth, the ends of which shall be fixed to the bed or to the side of the hoop destined to support the weight of the coverings. We take the precaution, also, to remove the anterior sharp edge of the bone at the place of amputation, in order to prevent the soft parts from being irritated thereby, and the interposition of a piece of linen during the first days, appears to us to contribute to this result. The projection of the bone becomes then impossible, except by penetrating through the whole thickness of the flap, which cannot happen when we take care to cut the bone sufficiently high."

I will add, (and I must here express my regret that I am not able to adopt the particular opinions of M. Sedillot, as to the best mode of dressings after amputations,) that with water dressings of whatever kind, the stump is always in a condition of excessive cleanliness, that the pus is carried off as fast as secreted, and no putrid fermentations can occur. In short, we can, at any moment, examine the wound, without causing the least pain to the patient. The stump, instead of being heated and compressed by compresses and bandages, lies free in a humid atmosphere, whose temperature the surgeon regulates at pleasure.

6. *What are the inconveniences which have been attributed to this means?*

If we refer to the cases which have been reported, we shall find that the first impression of cold water upon an injured part, especially if there is a wound, is generally very painful, and the more so in proportion as the

temperature is lower and the condition of nervous surexcitation more distinct. Sanson says he has seen many persons wounded by firearms, in whom cold water produced such intolerable pains as compelled him to suspend its use. Guthrie laid it down as a rule, that if cold water was disagreeable to the patient it must be renounced. M. Patry has noticed in the cases which he reports, the ill effects produced by the same cause. The same fact I also have been able to verify in the hospitals of Paris and in civil practice.

Gradually, however, the patient becomes accustomed to the cold water, so that it ceases to be painful, and remains thus until the inflammation subsides. Then the injured parts by returning to their normal state recover their natural sensibility, and the patient complains of pain: this is ordinarily the sign upon which we depend to suspend the water and to commence the cerate dressings. Such are the effects of cold water, while on the contrary, water at 18° or 25° (64° or 77°F.) does not occasion any painful sensation even at the first, yet it calms the excitement generally as well as the cold.

The application of cold water, especially in winter, produces horripilations and shiverings which continue more or less time. I have lately seen in one of the hospitals of Paris, a man who had had his hands crushed in the cog wheels of machinery. The surgeon, after having amputated two fingers, and approximated the flaps with diachylon plasters, submitted the hand to continued irrigations of cold water. The patient assured me that during the eight first days he experienced constant chills, despite all the means employed to keep him warm; but from this time he was able to endure the cold water without inconvenience for more than a month longer. When I saw it, on the sixth week, ordinary dressings had been commenced, and it was nearly cured. Such cases are common.

Sanson says he saw a female with whom a superficial burn seemed to indicate cool applications, and who was seized with tetanus soon after their use had been commenced. Again, M. Patry has reported the case of a young girl whom he subjected to applications of cold water upon the head, for a complicated fracture of the frontal bone; the mother having discontinued the applications on the fourth night, tetanus immediately supervened, and did not cease until the water was re-applied as at first. Thus we see that this grave complication may be produced both by the application of cold water and its sudden suspension.

"Mortification of the tissues, the accident which seems most to be feared from refrigeration so long continued," says A. Berard, "is extremely rare, and we have not seen it even in parts submitted to running cold water, unless they were already disorganized by the violence of the contusion. It is more

easily induced in the extremities of the limbs, and I have had the misfortune of seeing it twice occur upon the great toe.

"I will not say whether in this case the gangrene was produced by the contusion itself, or by the refrigeration; certainly I have seen wounds of the same nature, treated by the ordinary means, followed with gangrene of one or several phalanges, while others, submitted to irrigation, have been exempt. However, I believe I shall be able to establish the following principles. Whenever the contusion, complicated with a wound, leaves sufficient soft parts intact to permit the circulation to go on with ease through the whole extent of the limb, gangrene is not to be feared; but if in the thickness of the limb only a little structure remains which the contusion has not disorganized, even although the extremity beyond is perfectly uninjured, gangrene is not the less to be apprehended in the extreme portions. Cold water then acts without doubt with too much energy, and under its sedative influence the circulation is retarded, and perhaps even completely suspended in the tissues which the contusion has spared, and life is extinguished in every part which has lost its vascular connection with the rest of the body."

Goursaud reports a case of Guyenot's, in which ice having been applied an hour or two upon a strangulated crural hernia, the hernia was not reduced, and the surgeon, obliged to resort to an operation, found the epiploon frozen; the intestinal knuckle was, however, not injured, and the patient recovered.

I have notes of the case of a patient affected with a phlegmonous erysipelas of the arm and forearm, with whom the continued application of ice produced a solidification of the pus, so that for its removal it became necessary to resort to shampooing, and very firm graduated compression.

My father has been often consulted on account of a gangrene which he has thought ought to be attributed to the employment of very cold water; among the cases of gangrene which I have myself seen, there are several which must be ascribed to the same cause.

I have collected also several cases of patients who having been submitted to irrigations with cold water, have suddenly died with some nervous malady. What part does the cold play in the development of these phenomena? Without being assured that it is the principal cause, I believe I can at least say that it has some agency.

"Who will affirm," says M. Richet, "that the application of a powerful refrigerant upon a large surface will not, by repelling inward upon the viscera the blood which originally abounded in the diseased part, occasion congestions, and give birth to those complications to which I have alluded! The

facts are every where to be seen, and the practitioner ought to profit by them."

"It is well known," says Sanson, "that cold applications may cease to be useful, and may even become hurtful, by rendering the flesh œdematous, and pale, and causing it to become irritable when suppuration is established in the wounds. Sometimes also they entirely prevent the development of inflammation to such a degree as that at the end of twelve or fifteen days the wound is still in nearly the same condition as at the moment of the accident."

M. Apvrille reports a fact upon this point, which occurred in the service of M. Jobert. A woman had received a blow from the horn of a cow, which had torn extensively the skin and superficial muscles of the abdomen; cold water compresses were applied and renewed every ten minutes; when this mode of treatment had been pursued for some time, the wound was found to have made no progress toward a cure, and the cold was suspended. The next day a violent inflammation ensued; again the cold water compresses were applied, and the wound returned to its original condition. A renewed suppression of the compresses was followed by a yet more intense inflammation. Gradually a flabbiness supervened, and the patient died.

M. Cloquet has remarked to me that he has observed the phenomena noticed by Sanson, in debilitated subjects, when cold has been used perseveringly.

"Cold," says Tanchou, "is only suitable for the young and robust; with feeble persons, the very old, and with infants, it is always injurious." This proposition is the more true as the time of the application is more prolonged.

One will ask, perhaps, why the accidents of which we speak are not observed more frequently? I answer, that in general surgeons have not taken care to note them, and farther, the temperature and the quantity of water employed in a given time being seldom indicated in the report, it is difficult to understand exactly the degree of refrigeration produced, and whether, therefore, the accident ought or ought not to be ascribed to the cold.

In fact, as to the direct effect of the cold in these cases, M. Nivet thinks that water a little below the temperature of the part, acts not so much by abstracting caloric, as by diminishing the vascular circulation.

If we examine now the condition in which patients are placed, we shall not fail to be convinced that cold, which is easily borne by a man strong, robust, and healthy, having proper exercise, and taking sufficient nourishment, cannot be so well borne by a man suffering, obliged to keep his bed,

breathing an air more or less impure, and not using his ordinary but an insufficient nourishment.

We see from what precedes, that if cold water possesses some great advantages, it has also many inconveniences, and under certain circumstances it becomes even dangerous. We ought then to prefer tepid water, which calms the pain, and produces the desired effect of subtracting the caloric without exceeding the proper limits, and without exposure to any of the inconveniences of cold water, such as chills, too sudden suppression of the inflammation, and especially gangrene.

I must not omit to say, in closing my reflections upon the use of water, that there are certain constitutions in which it does not present favorable results, whatever precaution we may take. In those cases, which it is nevertheless impossible to foresee, we ought, when the idiosyncrasy becomes known, immediately to abandon it, and substitute for the water, perhaps the *appareil a incubation* of M. Guyot, perhaps the *appareil ouate* of Dr. Burggraeve, of Ghent, or other such means as now may be regarded as suitable.

The diseases in which water has been employed with advantage, and which constitute the subject of the numerous cases in my possession, are *simple inflammations, erysipelas, burns, ulcers, gangrene, wounds simple and contused, gunshot wounds, wounds from operations, amputations, &c., hemorrhages, contusions, affections of joints, hernias, diseases of the eyes, diseases of the genital and urinary organs of males and females.*

The application of water upon any portion of the body does not dispense with the necessity of ordinary medical means. When indicated, we are still to resort to bleeding, purgatives, emetics, &c. Water, acting locally, calms, it is true, the inflammatory symptoms, in the part subjected to its action; but it cannot neutralize the effect already produced upon the whole system. Nevertheless, when employed as soon as the lesion is produced, it is found in a great many cases sufficient in itself alone to prevent all reaction, and may constitute the sole treatment. It is easily comprehended that the case is altered when several hours or perhaps several days have elapsed since the occurrence of the accident; the general symptoms which have become developed may then demand the employment of those medical means of which I have just spoken.

In this part of my essay, I have only spoken of simple water, which will suffice in a great number of cases. Nevertheless, I think that we may obtain some advantages from water charged with medicinal substances; but this question is one of those which I am obliged to pass over at present, and reserve for a future time.

CHAP. III.

PRINCIPAL MODES OF APPLICATION OF WATER IN SURGERY.

The various modes in which water has been used in surgery, may be arranged under three grand divisions, viz., *water-dressing*, *irrigation*, *immersion*.

Water-Dressing.—In surgery we give the name “dressing” to objects which are applied to a wound, and the name “water-dressing” to these same objects wetted and kept moist during more or less time.

Without intending here to enter into a history of “water-dressings,” we will nevertheless say that this was the mode of using water adopted by Lombard, Percy, Larrey, Treille, &c., and to which we have already referred.

The ancients, who preferred usually a gentle moistening, with a mild temperature, employed, in place of lint, discs of sponge, of various thicknesses, which they laid carefully upon the wound, so as not to incommode the part by its weight. The application of the sponge was either mediate or immediate, and as it absorbed much water it retained its moisture a long time. They took care also to supply the water which it lost by absorption or evaporation by renewing it from time to time. By these means they were able in many cases to maintain about the injured part such a suitable moisture as contributed both to the comfort of the patient, and to the cure.

Percy, who has studied with care the effects of water in a great number of affections, and who has noticed the inconveniences inseparable from cataplasms and fomentations, has made the following experiments with a view to find a material which would advantageously replace them, and at the same time retain the moisture and the warmth: “If we take,” says he, “a piece of linen, another of common cotton cloth, a third of fustian, a fourth of English dressed flannel, and a fifth of soft flannel, all of the same size, and saturate them with distilled water; if now we suspend them side by side, at the same height, exposed to the same degree of heat on a summer’s day, we shall find that the linen will dry almost immediately, the cotton soon after, the English flannel will be three times longer, and the soft flannel will remain wet some hours after the others are dry.

It is true that the soft flannel will have absorbed the most, and progressively each will be found to have absorbed less and less until the linen will be found to have absorbed the least of all: but by multiplying the pieces, or by folding them together, and thus making them absorb the same quantity of water as a simple piece of soft flannel, we shall still see that the linen with all its folds will dry six times as soon as this flannel. It will be proportionally the same also, with the other fabrics mentioned.

Without doubt the best vehicle for water used as a topical application, and that which ought to supply the place of cataplasms, fomentations, &c., is soft flannel, which, in addition to its property of retaining much more of this liquid than any other tissue or material, prevents also its becoming suddenly cooled, being, as we say, a very bad conductor of caloric."

While we recognize the advantages which soft woolen flannel (*molleton de laine*) possesses over other fabrics, we by no means consider it free from every objection, especially in winter, or in cold and damp countries; Percy himself has observed this, and when he wishes to relax and soften a part and retain a perpetual moisture, (in a word to obtain all the advantages of cataplasms without their inconveniences,) he advises to saturate the linen with tepid water, and then lay over it a piece of oiled bladder, glazed linen or taffeta, and even parchment softened in sweet oil.

The difficulty of maintaining water at a mild and agreeable temperature in cold and humid countries has without doubt led Percy to cover the pieces holding the water, with an impermeable tissue; the same consideration has probably determined Liston, and, after him, the surgeons of the hospital of the University of London, to give the preference to this kind of water-dressings, which they employ almost exclusively.

M. Morton informs us that in this establishment they have banished every form of greasy dressings, and that they proceed as follows, in employing simple water or occasionally water medicated: they take a thick piece of charpie, (lint,) which is to be moistened more or less with tepid water, according to the indications; they place it on the wound, and cover it with oil cloth to prevent the too rapid evaporation of the liquid. From time to time, usually every three or four hours, the lint is removed and dipped in water, and if the suppuration is very abundant, or of a bad quality, it is renewed each time.

Josse and A. Berard employed at first compresses wet with water; but they soon became dissatisfied with this method. The part under treatment was found to be subject to frequent alternations of heat and cold, since the moistened compress became rapidly heated when not regularly renewed; A. Berard also remarks that such constant attention as this mode demands is sufficiently difficult during the day, but during the night it is almost impossible. It is easily comprehended how many circumstances may interpose to prevent a regularity in the temperature, and to induce a transition from cold to heat or from heat to cold. Hence these two surgeons were led to the adoption of continued irrigations, and this was a great step in the progress of surgical therapeutics.

M. Malgaigne gives the name of *intermittent irrigation* to lint moistened and applied as above.

But water-dressings, that they may prove useful, and be exempt from the inconveniences heretofore urged against them, must fulfill the following indications.

1. They must permit the pus to escape freely as fast as it is formed, and to be absorbed by the dressings.
2. They must be kept constantly moist.
3. Evaporation must be prevented, lest the part should become chilled, or in other words a uniform temperature must be preserved.

We think we have accomplished these several indications by a water dressing which my father and myself have much used, formed of four pieces of different tissues regularly superposed, which pieces may be called respectively the *sifter*, (*crible*,) the *absorbent*, the *humectant*, and the *inevaporant*.

Sifter.—The *sifter* is a tissue perforated with a great number of holes, to allow the pus to escape as fast as it is formed, and to separate the wound from the substance which absorbs the purulent matter.

The necessity of not permitting the pus to rest upon the surface of the wound has long been understood, and surgeons have been accustomed to cover the wound with a perforated compress spread with cerate. But the perforated linen used in hospitals and in civil practice does not fulfill the indications which we seek to obtain. Indeed, the holes being too small and too wide apart, and the pus becoming mixed with the cerate, the perforations are easily closed, and it serves no purpose whatever. With a view to remedy this inconvenience, my father first laid aside the cerate, and dipped the compress in water, but the pus still accumulated as before; he then used ordinary gauze instead of wetted compresses. The spaces which separated the threads in this tissue were too small, and the difficulty was not remedied.

Finally he tried common tulle with very open tissue, which perfectly answered the indication. This is the tissue which he decidedly prefers, and which he has named the "*sifter*."

If tulle cannot be obtained, we may use linen with larger and more frequent perforations, or strips of linen arranged in quadrille form, with larger spaces than are usually left.

Absorbent—Isolation of the wound being obtained, in the manner which we have described, my father next sought what would be the best means of absorbing the pus as fast as it was formed.

After having tried many tissues, he has concluded that old rags from linen or cotton, sufficiently worn, answered this purpose best. He places a

disk of proper size, after having moistened it with tepid water, over the *sifter*. This piece of dressing has received the name of *absorbent*.

Humectation.—Humectation being the principal indication to answer in water-dressings, it became important to ascertain what substance would best accomplish this.

After having tried, successively, discs of sponge, of soft flannel, of lint, of soft cotton, of agaric, &c., my father has finally given the preference to punk, (*amadon*), prepared without saltpetre or gunpowder. This substance, with little volume, absorbs much water, is soft to the touch, and yields its water to the *sifter* more easily than those which we have enumerated; We therefore generally prefer it. This piece of dressing has received the name of *humectant*.

Inevaporant, or impermeable tissue.—A last condition remains to be attained, that is, to prevent the evaporation of the liquid as much as possible. This indication has already been observed and answered by Percy, who placed over the compresses wet with water an impermeable tissue. In the same manner also we protect the water-dressings. Almost any impermeable tissue will answer the purpose, but it is proper to mention that as in the country the means are not always so abundant, a hog's bladder soaked in oil does very well. If we desire to prevent the evaporation completely, we must not neglect to make this cover larger than the other portions of the dressing, otherwise there will be along the borders of the dressing a slow evaporation, producing a coldness, especially in winter.

Dressings of the fingers, of the great toes, and of the penis, ought to be completely enveloped in the impermeable tissue so as to form a sac within which the moisture shall be retained. A piece of intestine or of caoutchouc made into a sac and placed over the member, will serve an excellent purpose.

An emollient effect being that which we wish generally to produce; we ordinarily use in these cases soft and tepid water at a temperature of 18° or 25° C., (64° or 77° F.) The liquid acquires soon the temperature of the part, especially if the impermeable tissue completely envelops the dressings, but if it does not, evaporation occurs, and a sense of chilliness results.

As to the time during which the application is to be continued without renewal, this must vary according to the effects which we wish to obtain, and according to the state of the parts. If the inflammation is active the dressings should be often renewed, and so also if the production of pus is very abundant. In simple cases, however, it will be sufficient to change the dressing every four or six hours.

This mode of dressing, less powerful than irrigations and immersions, has

the advantage of permitting the patient to attend to his occupations, when there is nothing to contra-indicate it.

When we wish to discontinue the water-dressing, it must not be done suddenly, but gradually, so as not to incur the hazard of a return of accidents. We must begin by diminishing the quantity of water employed in moistening the dressings, and then little by little make it cease altogether.

Compared with other modes of dressing, the water-dressing is infinitely superior, to cataplasms. We observe that in the great majority of cases it possesses all their advantages without their inconveniences, and as it can be easily maintained without being disturbed, it saves much pain to the patients.

I have already seen the dressing which I have now described used in a sufficient number of cases to induce me to hope that it will soon be preferred to fomentations, to compresses of lint and other tissues soaked in water, &c. I do not, however, reject, absolutely, cataplasms, which may be very useful in many cases, if properly employed, that is to say, they ought to be very moist, and frequently renewed, especially when there is a pretty abundant suppuration.

IRRIGATIONS.

In surgical language, irrigation (from the word *irrigare*, to irrigate) is the bathing of a part; but thus considered, as M. Malgaigne has shown, the sense of this word is vague, for affusions, injections, *douches*, etc., are bathings, and according to this definition, ought to be called *irrigations*. I think it is more suitable, and conforms better with common usage, to reserve the word irrigation to designate the uniform flow of a liquid over the surface of the tissues.

Irrigations demanding special apparatus, I will pass in review successively those means which have been employed by the various surgeons who have given most attention to this subject, and I will explain finally an extemporaneous method to which we may resort when the appliances are not at hand for any of the ordinary modes.

Apparatus of M. Josse.

M. Josse describes as follows the apparatus which he has employed for irrigations:

A vessel having a spigot near its bottom, is filled with water, and placed upon a narrow and high table, at the bedside of the patient. The table should be about eighteen inches above the wounded limb. An oil cloth is laid so as to protect the bed, and facilitate the escape of the water into a pail placed below and into which the extremity of the oil cloth is made to extend.

This apparatus may, however, be modified a thousand ways, and sometimes, doubtless, with advantage.

Two pails, which can always easily be obtained, may serve the same purpose, perhaps even more conveniently. One, having a spigot, or in which simply a hole has been made, is suspended above the bed; the other is placed beside the bed to receive the water as it flows off. That the direction of the current may be more easily changed, it is well to adjust to the spigot, or insert into the hole which has been made, a tube of some kind, and if possible, a gum elastic tube, the flexibility of which renders it very convenient. Even the oil cloth can be replaced by some other material; thus the ancients used the skin of an animal. This method might perhaps be revived advantageously, for while a prepared skin does not allow the water to filter through it, it imbibes, nevertheless, a certain amount of moisture which gives it a useful suppleness and coolness. We may also replace the oil cloth with a sheet of metal or of any other impermeable substance. But the best way to use such solid bodies is to form of them a gutter, in which the limb may be laid upon some soft body capable of absorbing moisture. But it should be especially borne in mind that the parts must not be kept exposed to the air.

Every thing being arranged, the diseased part is placed in the most convenient position; it is covered with compresses loosely laid upon it; another strip of cloth (*where the tube is not in use.*—T.) is secured at one end around the spigot, and the other reaches to the dressings, resting first upon that part of them which is the most elevated, and from thence extending downward along the limb. This is designed to prevent the water falling with its whole weight upon the diseased structures, and also to disperse it over a wider surface."

M. Breschet's apparatus for irrigation.

"We should have two large pails, one full of spring or well water, and the other empty. The latter is placed at the foot of the bed of the patient to receive the water which bathes the limb. We suspend the pail containing water to the tester of the bed, by a strong block or rope, or in any other way; we arrange it so that the bottom of the pail shall be directly over the wounded limb, and one or two feet above it. Then we must have a small glass or tin tube, of about the size of the little finger, bent at a very obtuse angle near its middle, so as to represent the letter U, with unequal branches of about three or four feet in length. We place one branch of this tube in the pail of water, and the other hangs over the wounded limb, the middle resting upon the edge of the pail. By a well known law of hydrostatics, the

water may be immediately made to pass from the pail through the tube, and be thus conducted upon the diseased limb in a jet. In order, however, to set the current in motion, it is necessary to produce a momentary vacuum in the tube, by applying the mouth to the extremity of the outer branch. The water now passes in a continuous stream through the tube, upon the limb. But to secure all its possible advantages, two conditions are necessary. First — The water must not fall from a great height; and this is why it is important that the external branch should be very long, or the pail hung as low as possible. Second — The stream of water must be very fine and continuous; which may be effected by a small perforated cork adjusted to the outer extremity of the tube, or by what answers the purpose equally well, a bit of sponge introduced in the same manner. This water, after having impregnated the compresses, the bandages and the lint which envelopes the limb, passes to the limb itself, bathes it, and falls upon the oil cloth, to be conducted from the bed into the empty pail of which we have spoken. The surgeon or the attendant, has only to renew the water in the pail above as often as it becomes empty. The bandages and the dressings of the wound should be renewed every second or third day, or even less frequently, according to the judgment of the surgeon.

Apparatus of A. Berard.

The apparatus of A. Berard is like that of Breschet; except that in place of a single metallic syphon, the mouth of which is closed with a cork more or less fluted, he employs one or several tubes of glass of small diameter, according to the degree of refrigeration which he desires to produce.

M. Velpeau has figured in his *Operative Surgery* (vol. 1, p. 265 of the original, and vol. 1, p. 217 of the translation by Townsend.—r.) a pail furnished at its bottom with a spigot, which communicates with a horizontal tube of the length of the limb to be bathed, and from this tube spring six other small vertical tubes, which direct the water upon the surface of the limb.

Apparatus of Mathias Mayor.

“A vessel of some kind, appropriate to contain water and to be suspended above the patient, must be pierced with one or more little perforations, destined to receive the ends of pack thread smaller than the perforations. The vessel being now filled with water it will escape and be conveyed along these threads to the parts which we wish to irrigate, and upon which these conducting filaments have been laid.

“The property which fluids possess of coursing along a material so easily procured as pack thread, and the facility of adjusting these strings so as to

enable us to regulate at will the quantity of water and its direction, these qualities, I say, are invaluable, and demand our consideration. But what is of still greater consequence, the water follows these threads wherever they are placed, even when they lie very obliquely. This liquid, in fact, does not easily leave its conductor, except when the direction of this conductor is nearly horizontal, or when it touches another object, or when there is a knot loosely tied in the course of the threads.

“In the second place, we can in this manner conduct the water from a distance, for however far the threads are stretched, they still continue to serve as aqueducts.

“A third fact to be noticed, is that the flow of water will be proportional to the size of the filiform conductor, the current being larger when the bundle of threads is larger, and the reverse.

“A fourth point of importance, is that the conductor is soft and flexible, and therefore is harmless if pushed against the sensitive parts, or if these are accidentally thrust against the apparatus.

“A fifth circumstance favorable to this plan, is that the liquid passes *imperceptibly* upon the part, and does not irritate by its fall; while a liquid cannot descend from tubes without a kind of shock being always felt at the place where it strikes the limb.

“A sixth consideration, and one which results directly from this absence of percussion on the part of the water, and from its gradual diffusion, as well as from the flexibility and suppleness of the conduit, is that the water will reach its destination even when there is some motion in the vessel or the threads, or in the part itself which is submitted to irrigation.

“We can easily distribute the water to several persons at the same time, and from the same vessel. This vessel is pierced with a number of holes, into which the ends of a corresponding number of threads are passed, and drawn through sufficiently to be secured to some point of the rim of the vessel. Each perforation not in use, is closed with a little plug, which may be removed at pleasure to permit the water to escape. To a like simple apparatus we can have recourse wherever the wounded are brought together in an ambulance, in a hospital, or in a carriage intended to transport one or more wounded.”

M. Mayor has also proposed to replace the syphon by a fillet of coarse cloth.

Apparatus of M. Guyot, Surgeon to the Hospital of Rennes.

This apparatus for irrigation is composed of three boards and a large tunnel. The boards are placed as follows: Two short upright pieces are se-

cured to either side of the bedstead, upon which the third board is laid transversely. This latter is perforated with a hole sufficiently large to receive the end of the tunnel, in which, when arranged, the tunnel is to be dropped, its mouth resting directly over the part to be irrigated. The oil cloth must be placed so as to protect the bed and drain off the water in the usual manner.*

M. Chaumette, of the hospital of Saint-Andre, at Bordeaux, employs also a large tunnel, which he suspends over the bed of the patient. From the lower orifice of the tunnel a bundle of pack thread reaches to the part which he wishes to irrigate.

Apparatus of Dr. James Macartney.

"This is a box made of zinc, much like a fracture box, in which the upper or lower extremities of the patient may be placed. The water, or the medicated fluids are conducted by means of a flattened tube, of which one extremity is joined to the reservoir, and the other traverses the upper wall of the box. This tube contains a band of coarse cloth, which is large at one end, and at the other terminates in a point. The first is received in the vessel which contains the liquid, the other rests upon the dressings, or is suspended above them. The water follows the band of cloth by virtue of capillary attraction, or after the manner of a syphon. For the purpose of draining off the water, the box has a concave bottom, pierced with large holes, through which the liquid may escape underneath; from whence a tube conducts it into another vessel placed without the bed. The member rests in the box upon a soft cushion, covered with an impermeable cloth."

Apparatus of M. Equisier.

This apparatus is composed, as we know, of the body of a pump in which moves a heavy lead piston. At the lower extremity of the reservoir is an orifice furnished with a spigot, to which also is attached an elastic tube designed to conduct the water; the liquid is forced out by the weight of the piston. This apparatus is very convenient because it can be placed upon any piece of furniture near the bed of the patient; but in general it is too expensive to be much employed, if it is of a proper and convenient size. Those ordinarily used are very small and necessarily require to be refilled constantly. The same is true of all those numerous different forms of apparatus in which

* The translator has taken great liberty with this paragraph on account of the careless, or perhaps he ought rather to say, *idiomatic*, manner in which the description is given in the original. Similar liberties have occasionally been taken elsewhere, when the correct understanding of the text seemed to demand it.—r.

the liquid is forced out by a piston put in motion by galvanized caoutchouc tubes or strips.

Our own apparatus and method of irrigation is as follows:

A sufficiently large vessel, of zinc or earthenware, is placed upon an elevated piece of furniture, near the bed; an elastic syphon, furnished with a stop-cock, guides the water from the reservoir upon the tissues. The part undergoing irrigation, is quite insulated by the aid of a gutter, or of impermeable cloth so arranged as that the water does not moisten the neighboring parts, and escapes freely into a vessel placed near.

A compress placed upon the member, serves to disperse the water uniformly. Ordinarily we adapt to the extremity of the syphon tubes, a strip of linen divided into bandalets which serve not only to direct the liquid, but principally to obviate its dynamic effect.

Once mounted, this apparatus works of itself, provided that care is taken to prevent the vessel from becoming empty, so that the flow of water may not be intermittent. We ought also to be particular in relation to the cleanliness and especially the temperature of the water, which should always be uniform, and not cause any disagreeable sensation to the patient.

When we wish to submit an extensive surface to continued and abundant irrigation, we ought to employ an apparatus which discharges its water in several streams, rather than one which is furnished with a single large conductor. In fact, when the water flows in a large stream it becomes warmer as it passes over the tissues, and the whole surface is not submitted to a uniform temperature.

If continued irrigations are to be made in any case with cold or ice water, it will be best to commence with tepid water, and gradually lower the temperature. Without this precaution, we are in danger, not only of causing to the patient very disagreeable sensations, but even grave accidents. In a case of extensive burn, Sanson saw tetanus supervene in consequence of the application of very cold water.

In pursuance of the principle which we have sought to establish, we ought to be exceedingly careful that the temperature of the water is not suddenly changed, and especially that its current is not interrupted, for a severe inflammatory reaction might result. When it is thought proper to suspend the water, its temperature should be gradually raised, and we ought even, as Cloquet advises, apply it for only a few hours each day before withholding it completely.

The quantity of water, it appears to us, should be regulated by the degree of inflammation, that is to say, if it is feeble a continued moisture will suffice;

if very intense, on the contrary, the fluid should be poured upon it very rapidly, inundating, so to speak, the part, especially if the water used has a temperature of 18° or 20° C. (64° or 68° F.) This liquid placed in contact with the tissues subtracts morbid caloric, and the more there is developed, the more water should be poured on, taking care, however, that the temperature is not too much below the standard of health.

The irrigation ought to be made, not only upon the part wounded, but also upon a considerable extent of surface about; without this precaution, serious accidents may occur, in parts which we supposed to be at first sound, and when no inflammation is developed at the point of injury, which is submitted to the action of the water.

I possess many cases which prove clearly, that persons wounded have succumbed from accidents developed in the vicinity of the point where the irrigation was made, and this doubtless explains why some authors have said that water masks the phenomena of inflammation, and does not prevent the development of purulent channels. I do not deny that this may happen, even when irrigation is well applied; but I am persuaded that in most cases the cause will be found in the application of the water to a too limited surface.

The absence of any of those materials of which I have spoken, often compels the surgeon to modify his apparatus; I shall, therefore, notice hastily the means which will be found most convenient in such an emergency.

For the upper receptacle we may use almost any vessel, but especially a pail of zinc or of wood, such as may be found almost everywhere.

In order to have the vessel above the part to be irrigated, we can, if it is a pail, suspend it to a nail in the wall, or place it upon a chair elevated upon a table. My father often uses a double ladder, upon the rounds of which he places a board, and on that the vessel. The pail may be also suspended from a strong pole sustained in the same way as the board.

In the country we find quite often, bedsteads with upright posts, to which we may secure a cross piece, which will answer the purpose. Two high tables, one being placed on each side of the bed, may be used instead of the posts. In short, we can in an emergency make irrigations with a simple watering pot.

In civil hospitals, the upper vessel, usually a pail, is suspended from the horizontal iron cross bar, which supports also the chord with which the patient aids himself in his movements. I could mention other modes, but these will suffice.

To the lower part of the vessel we may attach a small stop cock, and to

this a strip of linen, which will serve to direct the stream of water: a small common fountain would answer the purpose also well enough.

Temperature most suitable for irrigations.—Upon this subject I will only add to what I have already said when speaking of temperature generally, that cold irrigations have almost always been employed by MM. A. Josse, Berard, and Breschet, and that after having experienced some of the inconveniences of cold they have concluded that we ought to be governed by the sensations of the patient in determining upon the degree of heat or cold.

According to our own experience, tepid water is preferable in a majority of cases; yet it is wrong to proscribe cold water absolutely, as we have before said.

How long the irrigation ought to be continued.—It is difficult to fix the proper duration of irrigations, for it must depend upon the nature of the affection, the temperament of the patient, the stage, whether acute or chronic, of the malady. Nevertheless I will state some of the rules which surgeons most accustomed to the use of irrigations, have laid down.

Those who employ cold or ice water, are in the habit of suspending it when the patient complains of a feeling of cold in the part submitted to its action; but we must not be too hasty, for M. Josse tells us “that under these circumstances he had but too often seen the inflammation reproduced in all its former intensity;” and we have ourselves often verified the justness of this remark. It will be advisable then, not to suspend the application of the water, but gradually to raise its temperature until the patient no longer experiences any disagreeable sensation, and not to change the treatment until all chance of inflammation has disappeared. When we use tepid water we may continue the irrigation a much longer time, since the process of reparation of traumatic lesions goes on very regularly under its influence. My father employs them ordinarily fifteen, twenty, or twenty-five days, and then he substitutes for them water dressings which he renews as often as may be necessary to preserve their moisture. We ought, however, to resume the irrigations when a return of inflammation is threatened.

I cannot here indicate all the cases in which irrigations might be employed. I will simply say that they can be advantageously employed in the most grave surgical accidents, in all violent inflammations which are with difficulty moderated or controlled by ordinary means, and also in severe wounds which secrete pus copiously.

After what I have said under the general considerations, I shall not dwell long upon the advantages of irrigations, and the inconveniences which have been ascribed to them.

Advantages.—In violent traumatic inflammations, water constantly renewed and kept at a uniform temperature, abstracts the morbid caloric, and afterwards, when supuration is established, the pus is removed as fast as it is produced, and we have less reason to apprehend purulent absorption and its consequences.

Inconveniencies.—In truth I know of none which may not be attributed to any other therapeutic agent if improperly applied.

If, for example, the temperature is too low, there may result a too violent repercussion of inflammation, gangrene, &c. If the water does not escape freely, but only irregularly, there will follow mischievous alternations of action and reaction, the same as if the temperature was irregular.

These points demand, therefore, the greatest attention.

It has also been said, that irrigations act superficially. The numerous cases of grave and deep lesions, in which this means has been employed with wonderful success, do not permit me to hold this opinion.

En resume, continued irrigation is a powerful means which has already rendered the greatest service in many cases, and which could render still greater service if it were better appreciated. I shall be happy if I have succeeded in recalling attention to this means, and if I have successfully shown that the inconveniences with which it has been charged, are due mostly to the too low temperature of the liquid employed. On account of the difficulty of finding an apparatus suited to all circumstances in which we may be placed, I have sought to indicate simple methods, and such as may be adopted everywhere. If, however, irrigations could not be employed, we might have recourse to immersions, or to the water-dressings.

IMMERSION.

Immersion is the act of plunging the body, or some portion of it, into a liquid; in a word, it is a bath, either general or local. In surgery, immersions being usually made during a certain period, and with a uniform temperature, and sometimes even with constant renewal of the liquid, it is proper I think, to speak of the immersion as *continued*, as we do of irrigation. Perhaps, also, the word *maceration* might be properly substituted for immersion.

The surgical employment of immersions dates back, I believe, to Lamoignon, as our readers can have seen in the historical part of this work. The three cases which he cites are sufficiently remarkable, and had I chosen to speak of those in which he employed mineral waters, I might have referred to others.

“There are,” says Percy, “external affections in which the local heat is so

intense as to dry rapidly the thickest compresses drenched with water. We risk nothing, then, in applying them *moderately cold*; and if the part can be *plunged in a bath*, nothing will more effectually check the fury of the vital actions, and restore calm and regularity to the orgasm."

Since Percy, immersions had been employed but seldom, except by the military surgeons, especially in cases of sprains, when in 1841, M. Charles Mayor published a memoir, entitled, *On the Localization of Baths upon the different parts of the human body*. In this very interesting work, the surgeon of Lausanne has endeavored to call the attention of surgeons to the advantages which can be derived from the use of water by immersion, and to make known the various kinds of apparatus which he has invented for the purpose of applying insulated baths to different portions of the body.

The apparatus of M. C. Mayor consists of metallic vessels adapted to the form and size of the part which they are destined to receive; they are terminated in *cul de sacs* if designed to bathe the extremities of the limbs, and open at both ends if intended for other parts, and furnished also with ruffles made of caoutchouc, or bladder, to prevent the water from escaping.

M. C. Mayor closes his memoir with the following conclusions:

"First — These different kinds of apparatus are easily obtained in any place, and at a small cost.

"Second — They enable us to localize a bath upon all portions of the extremities, and without the patient being obliged to put his limb out of the bed, or in a declining position, which is often fatiguing and sometimes mischievous or impossible; we ought always to be able to select and keep that position which is most convenient.

"Third — The liquid not undergoing any evaporation, will retain its warmth a long time, especially if we take the precaution to surround the vessel with a bad conductor of caloric. The slight subtraction of caloric resulting from the coolness of the walls of the vessel, will be compensated by the heat which the diseased limb supplies to the small quantity of water surrounding it.

"Fourth — If we wish to bathe the hand, the forearm, or the arm, the apparatus furnished with rings and cords, might, under certain circumstances, be suspended to the neck of the patient by means of a sling, and he could thus be permitted to go out and attend to his business while he is at the same time continuing his bath.

"Fifth — The liquid can be renewed without changing the position of the limb, or cooling the part which is subjected to the bath.

"Sixth — Since it is necessary to use but little liquid, the cost of combus-

tibles is almost nothing, and the trouble of preparing it is trivial; and if medicated baths are employed, they will also be attended with but little expense, even when such expensive articles as the iodurets, the sublimates, &c., are employed.

“Seventh — The vessel being hermetically closed, does not permit any of the volatile principle to escape which the water may contain.

“Eighth — The apparatus having two openings, can be used where we wish to submit a limb, or a portion of a limb, to a continued current of water. For this purpose we have only to adapt to the upper orifice an elastic tube communicating with a vessel placed at a height proportionate to the degree of impulsion we wish to give to the water. The inferior remains open, or it may be made smaller by inserting into it a perforated cork, or a stop-cock.”

Our learned colleague, Dr. Lebert, who has employed local baths with the apparatus of M. C. Mayor, says: “I have used these baths in a great number of cases, and found them most useful in the diseases of joints. In part as the result of experience, and in part by a natural argument, I have deduced the following therapeutical indications for their employment:

“If the integuments are intact in acute or sub-acute inflammatory affections, as for example in case of felons, inflammations of the ligaments or fibrous structures, either of the feet, hands or knees, etc., and in general wherever there is severe pain and tension, we ought to employ them to sooth, or even to encourage the bleeding from leeches. These baths generally preserve an equal temperature for a considerable length of time, and possess also the great advantage of keeping the parts from contact with the air. But we ought not to continue them more than an hour consecutively, as the longer confinement will incommode the patient. We have had occasion to observe the soothing effect of local baths, with the water of Lavey alone, in many cases of acute inflammation, and of abscesses occurring during the treatment of articular diseases, white swelling and caries. * * * It has seemed to me that the absorption of the water of the bath, in these cases, was greater in local baths almost hermetically closed, than in those taken by the ordinary method. In eight cases of diseases of the bones, I have seen the suppuration promptly diminished, and the condition of the soft parts improved, by this treatment. In several cases of white swelling and of caries of the foot, the patients could not endure the position requisite for the ordinary foot bath, while they have taken the local baths with the apparatus of Dr. Mayor, without changing their position, and while lying in bed.”

Immersion, or local baths, applicable chiefly to the extremities of the

limbs, are destined, in certain cases, to render great service to surgery, and to be of frequent use, owing to the ease with which they can be procured and administered. This method of applying water is exceedingly simple for lesions of the forearm or hand, and for the leg or foot. It is only necessary to place near the patient a vessel containing water of a mild and agreeable temperature, into which the part may be completely plunged. Care must be taken that the temperature of the liquid does not sensibly vary, and that it is renewed sufficiently often to keep it clean. For the arm, thigh, and pelvis, we may employ the very ingenious apparatus of M. Charles Mayor, junior, not forgetting, however, that their protracted use may be attended with inconveniences by the constriction which they produce above the diseased part. * * *

In order to determine the variations of temperature of the water, so that it may be renewed at the proper moment, we should use a thermometer; and for the greater convenience we may adapt two tubes to the bath, the one for the admission and the other for the escape of the fluid.

As to the position of the part undergoing an immersion, we can only say that we must always have regard to the escape of the pus and the return of the venous blood.

The good effects of prolonged immersions in water of a mild temperature, appear to me to be attributable, as in irrigations, to the subtraction of caloric, and also without doubt, to the absorption of the liquid, which penetrates the tissues. * * *

Water at 18° or 20° C (64° or 68° F) more or less, is generally preferable to cold water, and it is at this temperature that my father always employs it in his practice.

As to the duration of the immersions, it must vary much, according to the degree, extent, and depth of the inflammation, and it is impossible to establish precise rules; nevertheless, I think they ought to be prolonged sufficiently to insure against a return of the inflammation, and then they should be discontinued gradually, replacing them at first with water dressings.

To avoid the inconvenience of absolute confinement of the patient, we may in certain cases, as in lesions of the fingers and penis for example, use a pig's bladder or a caoutchouc bag, filled with water, into which the part may be immersed and secured.

In the most severe surgical accidents, we should commence, if possible, with immersions or irrigations, or both, and terminate with water dressings. Sometimes even we may unite the three modes for the purpose of avoiding

the usual painful dressings, and securing those great benefits which we have a right to expect from water.

Finally, immersion is a procedure which seems to us to have great efficacy in cases where the water is required to act upon the deep structures: here, therefore, it can be profitably substituted for irrigations, whose effects are in general more superficial.

In comparing the three principal modes, we observe that the water dressing, if properly made, and often renewed, is generally more simple, and more easily applied, than immersion or irrigation, that it has, moreover, the advantage of taking off at each dressing the pus and the stratum formed by a mixture of the purulent matter and the substances contained in the water; the granulations are thus kept always red, &c.

Irrigation is more powerful than water dressing, but more difficult, and sometimes even impossible to apply.

Immersion is more powerful than either, more prompt, and in all respects superior whenever it can be properly applied.

CONCLUSIONS.

The history of this branch of surgical therapeutics, proves that from the origin of the art of surgery, and even before this epoch, water was the agent to which recourse was instinctively had to assuage pain.

But soon miraculous waters, balsams, and ointments of all kinds, were employed, and their use was continued during a long succession of ages under the protection of barbarism and charlatanism.

At last that great school, the Academy of Surgery, did justice to polypharmacy, and directed all its efforts to simplify dressings; but it was only at rare intervals that a surgeon recognized the superiority of water for the accomplishment of this end.

Latterly, efforts have been made to demonstrate the utility of water: but hitherto the old methods have prevailed, irrigations only being employed, and even their use is very limited, and so to speak, exceptional.

Water used locally, at a proper temperature, is, in the treatment of surgical affections, the most powerful antiphlogistic which we possess; it is also the most easily procured and the most easily applied; it cleanses, cools the wound, and assuages the pain; it is, in short, the best balm, and, as Briot says, *le vulnérable par excellence*.

The use of water topically, embraces three principal modes under which all others may be classed; these are water-dressings, irrigation, and immersion.

Water-dressings, such as we have described, that is, properly moistened, and renewed, are destined to render important services to surgery.

Irrigation is an excellent means, which already has rendered much service; but it is too seldom employed, and, indeed, it has been almost abandoned, on account of the difficulty attending its application, and the accidents resulting from the too low temperature at which it has been generally employed.

We have sought to diminish its inconveniences by indicating more simple apparatus, and by insisting upon the use of tepid water, which it appears to us, ought to be preferred in the great majority of cases; still we think that immersion and water-dressings can often be substituted with advantage.

Immersion, or the local bath, more or less prolonged, is too much neglected, even where the parts can be most easily immersed; it is a means whose results are very prompt and infinitely superior to cataplasms, and even to irrigations or water-dressings.

By these three methods, separate, or combined, we can meet every indication and obtain results truly wonderful. It is sufficient to make trial of them in lesions of the fingers and penis, to force a conviction of their superiority over all other modes of dressing, and to ensure their application afterwards, in the most serious lesions, wherever their seat.

Finally, I have endeavored in this essay by historical documents, and by comparative experiments, to establish the advantages of water over every other topical application; and after the remarkable results which have already been obtained, I am encouraged to hope that soon this therapeutical agent will occupy the first place in surgery as a local antiphlogistic.

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FRANK H. HAMILTON,

In the Clerk's Office of the District Court of the United States, for the Northern
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